MONOGRAPHIC STUDIES ON NORTH AMERICAN SPECIES OF LAMPROSPORA (PEZIZALES)

By

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After the examinations of North American herbarium specimens with the use of squash mounts, frozen sections, and plastic thick sections, ninety-nine specimens were identified as species of Lamprospora. Among them, eighteen well defined species were recognized, eight of which were reported for first time in North America.

Phylogenic relationships within Lamprospora and among species of Octospora and Ramsbottomia were investigated by a cladistic analysis using Henning86. Pulvinula was selected as the outgroup and seventeen macroscopic and microscopic characters were used. The results of the cladistic analysis showed that Ramsbottomia is the sister group to the other two genera. The discovered cladograms also indicated that Lamprospora, as currently delimited, is paraphyletic, with

Octospora species nested within its cladistic structure. The genera Lamprospora and Octospora, thus, are not well separated and it was necessary to merge all species into Octospora because that genus has priority.

An emendation of Octospora has been made. A key, descriptions, and illustrations of eighteen species are provided along with a list of excluded species.

CHAPTER 1
INTRODUCTION

De Notaris (1864) established Lamprospora based on the species L. miniata De Not., which he collected during the autumn of 1862 at Val Intrasca. This species was described as: "Apothecia small, sessile, bottom with fine hyaline hairs, disc flat, with delicate margin. Excipulum thick, multi-layered. Asci thin-walled, cylindrical, 8-spored. Paraphyses filiform, apex colored, slightly expanded. Spores hyaline, globose, finely reticulate (1864, p.388)."

Although De Notaris noted the similarity of spore ornamentation with Ascobolus miniatus Cr., described earlier by Crouan (1858), he discounted these because the latter had only a one layered excipulum. Because Preuss (1851) had already named another fungus as A. miniatus Pr., Cooke (1864) renamed it A. crouani Cooke. Later mycologists have considered the above three names to be synonyms.

Fuckel (1870) proposed the genus Crouania for two species, C. miniata Fuckel, synonymous with A. miniatus Cr., and A. crouani Cook., and C. humosa (Fr.) Fuckel, which was transferred from Peziza humosa Fr. Crouania was put under Pezizei, Discomycetes. However, this genus was not accepted

by his contemporaries. Cooke (1879) and Phillips (1887), nevertheless, still put these two species under Humaria Fr., a subgenus of Peziza.

Saccardo (1889) noted that the name Crouania had been preoccupied by an algal genus. He replaced it with Barlaea Sacc. and cited L. miniata De Not., A. miniatus Cr., and C. miniata (Cr.) Fuckel, as synonyms under B. miniata (Cr.) Sacc. In his Sylloge Fungorum (1889), thirty four round-spored species were included in this genus, most of them transferred from Peziza. They were selected for having a small fleshy apothecium and hyaline globose spores. Barlaea was treated as a genus within the family Pezizeae. Later, Saccardo (1898) discovered Barlaea was also preoccupied by an orchid genus and substituted it with Barlaeina while adding four more species to this genus (Table 1).

In Rabenhorst's Kryptogamen Flora, Rehm (1896, p.915), following Saccardo, described Barlaea as "Apothecium disc-like, red or yellow, spores spherical, smooth or ornamented". Twelve species were included in this classification. Rehm assigned Barlaea to the family Eupezizeae, Discomycetes.

Boudier (1907) retained the name Lamprospora. By emphasizing microscopic characters, he divided discomycetes into two large groups: operculates and inoperculates. Seven families were recognized within operculates. Because of the presence of small red apothecia and asci do not turn blue in

an iodine solution, Lamprospora, Humaria, Pulvinula Boud., and five other genera were assigned to Humariaceae. Boudier suggested that Lamprospora was closely related to Humaria Fuckel (=Octospora Hedw. ex Gray emend Korf) since both genera contain species with glabrous apothecia and ornamented spores. However, the former is distinguished by round spores while the latter has subglobose spores. Later, Humaria was synonymized with Octospora (Rifai, 1968). In his Icones Mycologica (1905-1910) Boudier described four Lamprospora species and one variety, L. carbonicola Boud., L. miniata (Cr.) De Not., L. dictydiola Boud., Lamprospora crec'hquerault ii (Cr.) Boud., and L. crec'hqueraultii (Cr.) Boud. var. macracantha Boud. Seaver (1942) erected the last variety as a separate species which he named L. macrantha (Boud.) Seaver.

Schröter (1894) treated Barlaea Sacc., Crouania Fuckel., Lamprospora Boud. and eight other genera as subgenera under the genus Plicariella Sacc. within Pezizaceae.

Seaver (1912-1914) was the first to publish many North American Lamprospora species. Seaver (1942), divided the family Pezizaceae into seven tribes according to spore characteristics. Lamprospora was put into the tribe Sphaerosporeae by having globose, hyaline spores. Thirty species were included in this genus. However, he neglected two important taxonomic characters: the apothecial color and

ascal tip color reaction in iodine solution. Many of the species he placed in Lamprospora have been subsequently reclassified (Table 1).

Buckley (1924), working on British discomycetes, published a new genus Ramsbottomia Buck., which is based on R. lamprosporoidea Buck. This species resembles L. crec'hqueraultii (Cr.) Boud., but is distinct in the pilose exterior. A new Lamprospora species, L. campylopodis Buck. was also described in this article.

Clements and Shear (1931) put Lamprospora in the family Pezizaceae. In the published key, Lamprospora was distinguished by having glabrous apothecia, asci not turning blue in iodine solution, and hyaline globose spores. Lamprospora miniata Cr. was designated as the type for this genus.

Velenovský (1934) in Monographia Discomycetum Bohemiae, classified discomycetes into twenty-three families. Barlaea was assigned to the Humariaceae. Eighteen species were included in this genus and divided into three groups: A) spores smooth, rarely slightly verrucose, B) spores verrucose or echinulate, and C) spores reticulate. He described eight new species, two of them B. arvensis Velen., and B. minuta Velen. were still retained in Lamprospora (Benkert 1987).

Le Gal (1953) emended Barlaeina and described a group of fungi related to Ascobolus persoonii Crouan, which was

designated as the lectotype of Barlaeina. Rifai (1968), aware of the taxonomic confusion, abandoned Barlaeina and proposed Marcelleina Rifai to represent Le Gal's Barlaeina group.

Thind et al. (1957-1959) published a series of new species and varieties of Lamprospora collected from the Mussoorie Hills of the northwestern Himalayas in India. Thind differentiated L. trachycarpa (Curr.) Seav. var. ferrugines (Fuckel) Thind and Seth from the typical L. trachycarpa (Curr.) Seav. by the larger and more densely pustulate apothecia. Lamprospora spinulosa Seaver var. magnispora Thind has larger spores than those of L. spinulosa. Lamprospora haemastigma (Hedw.) Boud. var. gigantea Thind is similar to L. haemastigma except that its apothecia are larger while the ascospores and asci are smaller, and was transferred to Pulvinula by Waraitch and Thind (1977). Lamprospora mussooriensis Thind has smooth spores, and was transferred to Pulvinula by Pfister (1976). Batra (1960) added two more Indian species L. chopraiana and L. multiguttulata; both species have globose smooth walled ascospores, and are identified as species within Pulvinula in this paper.

Moser (1963) separated the Lamprospora species described by Seaver (1942) into two groups. Those with asci that turn blue in iodine solution were transferred to Plicaria Fuckel, while those with asci that do not turn blue

in iodine solution were kept in Lamprospora within the family Humariaceae.

Dennis (1968), working on the British Discomycetes, assigned Lamprospora to the tribe Aleurieae within Humariaceae. He stated that the tribe Aleurieae is a residual assemblage of genera, defined largely by negative characters, the absence of a blue ascal tip in iodine solution, the absence of clearly differentiated hairs, and the absence of asci protruding above the hymenial level at maturity. Also, he mentioned that Lamprospora differed from Octospora only in its globose spores which are usually conspicuously ornamented by a reticulum or by large spines.

Eckblad (1968) emphasized the structure of the excipulum. He divided Pezizales into nine families, which included the new family Pyronemaceae Corda emend Eckbl. This family contains twenty-one genera and is the largest family among Pezizales. Lamprospora, Pulvinula, and Pyronema Car. were characterized by having a small apothecium, glabrous exterior, and paraphyses with carotenoids. Eckblad also mentioned that Octospora probably differs from Lamprospora only in the shape of the spores. Three species were included here, a new species L. ovalispora (Svr. & Kub.) Eck. with ellipsoidal spiny spores was erected from L. crec'hqueraultii (Cr.) Boud. var. ovalispora Svr. & Kub.

Rifai (1968) discussed in detail the history and limits of Lamprospora. He characterized this genus by apothecia having a distinct dentate-fimbriate margin, the ectal and medullary excipula composed of polygonal cells, spores globose or subglobose, strongly ornamented with various constructions. Based on these characters, he transferred many of Seaver's Lamprospora species to Pulvinula and Plicaria Fuckel. Those having globose smooth spores, filiform paraphyses and textura intricata medullary excipulum were assigned to Pulvinula, and those showing iodine positive reaction were assigned to Plicaria. In the description of Octospora, he also stated that its scope is basically similar to that of Lamprospora, except that Octospora has ellipsoidal and mostly smooth or less elaborately ornamented ascospores, and a distinctly filamentous medullary excipulum. Both genera were put under the tribe Aleurieae within Humariaceae.

Arpin (1968), after studying the carotenoid pigments of the discomycetes, used the composition and distribution of these pigments to propose a new classification, establishing a new family Aleuriaceae characterized by having either beta carotene or gamma carotene. He did not treat species of Lamprospora, but placed O. calichroa (Boud.) Arpin, O. leucoloma Hedw. ex Gray., and O. rubricosa (Fr.) Quel. sensu Boud. in the family Aleuriaceae. Based on Arpin's research, Le Gal (1969) proposed a new tribe Melastizeae under

Humariaceae. Leucoscypha Boud. emend. Korf, Aleuria Fuckel., Melastiza Boud. and Octospora were included in this tribe by having both beta and gamma carotene. She merged Lamprospora into Octospora, because L. ovalispora has subglobose spiny spores and Octospora was defined on the basis of its ellipsoid or subglobose spores.

Octospora was first proposed by Hedwig (1789) for a group of apothecial fungi in which O. leucoloma Hedw. ex Gray was included. However, his recognition of Octospora was very broad and included many discomycetes. Gray (1821) took up the name Octospora in his Natural Arrangement of British Plants. After this, Humaria was used over Octospora. Korf (1954), in revising the classification of Pezizales, recognized that Octospora Hedw. ex Gray was older than Humaria (Fr.) Boud. He emended this genus, and designated O. leucoloma as its lectotype.

Kimbrough (1970) divided Pezizales into nine families, following Arpin's classification, which characterized Aleuriaceae as having either beta or gamma carotene. Lamprospora, was included in Aleuriaceae, along with Octospora because of the morphological similarity.

Korf (1972) divided Pezizales into seven families. The largest family Pyronemataceae Cord. emend Korf contained most genera of Humariaceae (sensu Rifai). Lamprospora with ten other genera were included in the tribe Aleurieae Seaver within Pyronemataceae.

Gamundi (1973) described a new species, L. cashii, a species close to L. spinulosa in having spiny spores, but with fewer and smaller spines on the spore surface. She (1975) also applied numerical taxonomic techniques in the classification of twenty-four collections of Lamprospora. These collections were previously identified as L. modesta (Karst) Nann., L. crec'hqueraulẗii (Cr.) Boud., and L. crec'hqueraulẗii var. macracantha Boud. The results showed that there is a greater similarity between L. modesta and L. crec'hqueraulẗii than between L. crec'hqueraulẗii and L. crec'hqueraulẗii var. macracantha.

Pfister (1976) published a synopsis of the genus Pulvinula, which included seventeen species, among them P. archeri (Berk.) Rifai, P. carbonaria (Fuckel) Boud., P. convexella (Karst.) Pfister, P. globifera (Berk. & Curt.) Le Gal, P. laeterubra (Rehm) Pfister, P. miltina (Berk.) Rifai, P. mussooriensis (Thind, Cash & Singh) Batra & Batra., P. orichalcea (Cooke) Rifai, P. ovalispora Boud., P. salmonicolor (Seav.) Pfister, and P. tetraspora (Hansf.) Rifai which he considered were related to Barlaea or Lamprospora. Excluded species and comments on globose spored species of Pezizales were also discussed, but the characters of Pulvinula were not defined clearly in this article.

Svrček (1976), in revising Velenovský's collections preserved in the National Museum of Prague, found Barlaea

melina Velen., B. modesta (Karst) Sacc. var. carbucula Velen., and B. retinosa Velen. as synonymous with L. annulata Seaver, L. crec'hqueraultii (Cr.) Boud. var. macrantha Boud., and L. dictydiola Boud. respectively, and B. arvensis Velen. and B. minuta Velen. were transferred to L. arvensis (Velen.) Svr. and L. minuta (Velen.) Svr.

Khare & Tewari (1978a) found two more species in India, L. irregulariata and L. varanasiensis. Both species have branched paraphyses, and ornamented spores.

Benkert (1976), working on German collections, separated Lamprospora into three groups, based on three major characters: moss associations, texture of the excipulum and spore ornamentation:

Group 1. Bryophilic (associated with mosses), spores ellipsoid with fine ornamentations. Excipulum is a textura intricata. This group is closely related to Octospora.

Group 2. Non-bryophilic, spore globose to subglobose ornamented with spines. Excipulum is a textura globulosa-angularis. The representative species of this group is L. crec'hqueraultii. Later, this group was transferred to Ramsbottomia (Benkert and Schumacher, 1985).

Group 3. Bryophilic, globose spores with conspicuous ornamentation. Excipulum is a textura globulosa-

angularis, often with a textura intricata outer layer. This is the typical Lamprospora group.

Two new species, L. feurichiana (Kir.) Ben. and L. schroeteri (Sch.) Ben., were described in this paper.

Itzerott and Thate (1978) transferred Octospora retispora Itz. & Tha. into L. miniata var. retispora. Although this species has ellipsoid spores, the textura angularis excipulum and the reticulation of spore surface are similar to L. miniata. This species was later erected as L. retispora (Itz. & Tha.) Sch. by Schumacher (1986) when he described a reticulate spored species, Lamprospora miniatopsis Spooner collected from Norway. Both Lamprospora retispora and L. miniatopsis have subglobose spores and are associated with the moss, Tortula.

Following Le Gal's (1969) emendation, Caillet and Moyne (1980) transferred fifteen Lamprospora species to Octospora. Illustrations of these species and a key were also provided.

Dissing (1981) described a species, L. leptodictya Diss., from West Greenland, which has subglobose spores and ornamentation similar to L. ascoboloides Seaver but with finer ridges, and this ornamentation disappears in 2% KOH in less than thirty minutes.

Continuing their early work, Benkert and Schumacher (1985) transferred the group 2, spiny spored species, to Ramsbottomia Buck. emend. Benkert & Schumacher, a genus established by Buckley (1924). Four species: Ramsbottomia

lamprosporoidea Buck., R. crec'hqueraultii (Cr.) Ben. & Sch., R. asperior (Nyl.) Ben. & Sch., and R. macracantha (Boud.) Bek. & Sch. were included in it. Humaria calospora Quel. [syn. L. calospora (Quel.) Mor. and O. calospora (Quel.) Cail. et Moy.] was assigned into a new genus Moravecia Benk., Cail. & Moy. (1987), within Pyronemataceae, because of the non-bryophilic habitat and ellipsoidal reticulate ascospores. He restricted Lamprospora to those species with globose, strongly ornamented spores, growing with mosses (Benkert, 1987). Six types of spore ornamentation were classified and specific moss hosts were listed under each species description. Thirteen new species were also described (Table 1.)

In the present study, herbarium specimens previously identified as Crouania, Barlaea, Barlaeina, or Lamprospora and specimens related to Lamprospora but labeled as Ascobolus, Humaria, Octospora, Peziza, and Ramsbottomia were studied and in some cases, reclassified. Ninety-nine specimens are recognized as Lamprospora and divided into eighteen species. Eight of these species are reported for the first time in North America. The remaining specimens have been reassigned to thirteen genera.

Phylogenic relationships within Lamprospora, and among Octospora and Ramsbottomia were determined by using cladistic analysis. An emendation of Octospora was made.

A key, descriptions of eighteen species, and a list of excluded species are also provided.

Table 1. *Lamprospora* species listed by Saccardo, Seaver, and Benkert

Saccardo's (1898) *Barlaeina*	Seaver's (1942) *Lamprospora*	Benkert's (1987) *Lamprospora*
B. amethystina^	*L. amethystina*^	*L. annulata*
B. arenaria	*L. annulata*	*L. areolata*
B. asperella~	*L. areolata*	*L. arvensis*
B. astroidea	*L. ascoboloides*	*L. ascoboloides*
B. calospora♣	*L. brevispinosa*	*L. australis*
*B. carbonaria**	*L. carbonaria**	*L. cailletii*♦
*B. cinnabarina**	*L. constellatio**	*L. campylopodis*
*B. constellatio**	*L. crouani*	*L. carbonicola*
*B. convexella**	*L. crec'hqueraultii*~	*L. dicranellae*♦
B. crec'hqueraultii~	*L. detonia*"	*L. dictydiola*
B. endocarpoides#	*L. discoidea**	*L. ditrichi*♦
B. epichrysea	*L. exasperata*#	*L. faroensis*♦
B. exasperata#	*L. gemmea**	*L. feurichiana*
B. fuliginea#	*L. haemastigma**	*L. gotlandica*♦
B. fuscobadia	*L. laetirubra**	*L. hanffii*♦
*B. gemmea**	*L. leiocarpa*#	*L. hispanica*♦
*B. globifera**	*L. lobata*▲	*L. leptodictya*
B. globulosa	*L. maireana*	*L. lutziana*
B. hinnulea@	*L. macrantha*~	*L. maireana*
B. hypnina	*L. nigrans*#	*L. miniata*
*B. knajaschensis**	*L. planchonis*'	*L. minuta*
B. lobata▲	*L. polytrichina**	*L. moynei*♦
B. miniata	*L. salmonicolor**	*L. paechnatzii*♦
*B. miltina**	*L. spinulosa*	*L. rehmii*♦
B. modesta~	*L. trachycarpa*#	*L. retispora*
B. musiva	*L. tuberculata*	*L. rugensis*♦
*B. orichalcea**	*L. tuberculatella*	*L. seaveri*♦
B. polytrichi	*L. wisconsinensis**	*L. tortulae-ruralis*♦
B. persoonii^		
B. planchonis'	*L. wrightii*+	*L. tuberculata*
B. recurva#		*L. tuberculatella*
B. rickii^		
B. schizospora@		
*B. subaurantiaca**		
B. viridis▶		
B. wrightii+		

' species now in *Greletia*
^ species now in *Marcelleina*
' species now in *Peziza*
* species now in *Pulvinula*
" species now in *Scabropezia*
@ species now in *Sphaerosporella*
♣ species now in *Moravecia*
▶ species now in *Leucoscypha*
▲ species now in *Lazuardia*
+ species now in *Octospora*
# species now in *Plicaria*
~ species now in *Ramsbottomia*
♦ new species

CHAPTER 2
MATERIALS AND METHODS

Letters were sent requesting specimens catalogued under Crouania, Barlaea, Barlaeina, Lamprospora, and Ramsbottomia. Nine of the twelve correspondents shipped specimens while the rest responded that their collections did not include the requested items. Specimens of Ascobolus, Humaria, and Peziza were also received. Owing to the scope of the present study, a later request was sent to the responding herbaria for specimens of selected species of Octospora. The standard abbreviations for those responding herbaria are used and listed below (Holmgren et al 1981):

BPI National Fungus Collections, Beltsville, Maryland, USA

CUP Plant Pathology Herbarium, Cornell University, Ithaca, New York, USA

DAOM National Mycological Herbarium, Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario, Canada

FH Farlow Reference Library and Herbarium of Cryptogamic Botany, Harvard University, Cambridge, Massachusetts USA

GAM Julian H. Miller Mycological Herbarium, Department of Plant Pathology, University of Georgia, USA

FLAS Herbarium, Florida Museum of Natural History, University of Florida, Gainesville, Florida, USA

MICH Herbarium of the University of Michigan, Ann Arbor, Michigan, USA

NY Herbarium, New York Botanical Garden, New York, USA

SFSU Herbarium, Department of Biological Science, San Francisco State University, San Francisco, California, USA

BHU Bereich Botanik und Arboretum des Museums für Naturkunde der Humboldt Universität zu Berlin, Späthstrasse, Berlin, Germany

In addition, two specimens were sent by Dr. D. Benkert of Humboldt University, in Berlin.

Shrinkage of the apothecium was noted as a particular problem with dry specimens. Many specimens are extremely scraggly, no apothecia were located and a few pieces of soil with moss stems are left in the packet. In these cases, reidentification was made by examining the slide within the packet. Occasionally, no identification could be made.

The associated mosses were identified by Dr. D. G. Griffin III, at the University of Florida. Dried apothecia were picked up under a dissecting microscope, the surface was wetted with a drop of 95% ethanol, and then rehydrated in distilled water for 20 to 30 minutes. Squash mounts using various mounting or staining agents were made from the rehydrated apothecia in order to observe the structures of

the asci, paraphyses, and ascospores. The blueing of asci was checked by using Melzer's reagent. A drop of 2% KOH solution was applied to the slide to test the dissolving ability of spore ornaments, Sudan IV was used to test for the presence of fat, and Congo red and acid fuchsin were used to differentiate ascal wall layers. Spore ornaments were stained with cotton blue in lactic acid as recommended by Le Gal (1947) and Korf (1952).

The structures of apothecia were examined using frozen sections and plastic embedded thick sections. A fully rehydrated apothecium was placed on the stage of a CTI (International cryostat) freezing microtome, embedded in a drop of 40% aqueous mucilage, and sectioned at 25 μm. Sections were placed on slides, stained with cotton blue in lactic acid, and observed under the light microscope.

Rehydrated apothecia were fixed in glutaraldehyde for one hour, and in osmium for another hour, dehydrated in a series of ethanol, and then embedded in epoxy resin (Spurr 1969). Plastic blocks were sectioned on a LKB Huxley ultramicrotome at 1 μm thick. Sections were picked up on slides, stained with Azure blue and Methyl blue, and observed under a light microscope. Permanent slides were made by mounting with permount.

All measurements were made in distilled water. Ascal shape, length and width, paraphysis diameter of tip and basal part, spore diameter, ornaments shape, height and

width were examined and measured. Observations of apothecial structure were taken from the central part of each apothecium. Cell shape, size and thickness of various layers were recorded. The terms used to describe the tissue structure follow the definitions of Eckblad (1968).

textura angularis: Polygonal cells without intercellular space.

textura intricata: Interwoven hyphae, running in all directions, usually with interhyphal space.

textura porrecta: Hyphae running in one direction, more or less parallel, with wide lumina and thin walls.

Drawings were made from slides under a light microscope equipped with a drawing tube. Photographs were taken with a Nikon UFX-II photo system.

Ornamentations of ascospore were observed by using a scanning electron microscope. A fragment of apothecium was taken from a dry herbarium specimen, attached on a stub, and coated with gold in an Eiko IB-2 ion coater for six minutes at 8 mA prior to examination with the Hitachi S-450 scanning electron microscope.

CHAPTER 3
ECOLOGY AND MORPHOLOGY

All species of Lamprospora are bryophilic (Benkert 1976, 1987). Past mycologists recorded their habitat as on soil among mosses (Seaver 1942, Rifai 1968). Benkert (1976), while studying German species of Lamprospora, showed that each of these species was associated with a particular moss genus. Döbbeler (1979) interpreted this association as rhizoid parasitism by showing the presence of appressoria and haustoria of L. carbonaria and L. aff. miniata in the rhizoids of Funaria hygrometrica and Tortula norvegica respectively. Benkert (1987) agreed with Döbbler's conclusion. Whether this association is parasitic or not, a relationship definitively exists between Lamprospora species and certain moss genera. The Lamprospora species and their associated moss genera are listed in Table 2. With the exception of L. annulata, most of them are similar to those of Benkert (1987).

It should be noted that many Lamprospora specimens are associated with blue green algae. In many cases, blue green algal cysts were found closely attached to the apothecial surface. However, the relationships between the algae and fungi are beyond the scope of this paper.

Table 2. *Lamprospora* species and associated mosses.

Fungal species	Moss taxa	
Lamprospora	Wang (1991)	Benkert (1987)
L. annulata	*Campylium*	*Pleuridium*
L. areolata	*Funaria*	
L. arvensis	*Ceratodon*	*Ceratodon*
L. ascoboloides	*Dicranella*	*Dicranella*
L. australis	*Campylopus*	*Campylopus*
L. carbonicola	*Funaria*	*Funaria*
L. campylopodis	*Campylopus*	*Campylopus*
L. ditrichi	*Ditrichum*	*Ditrichum*
L. dicranellae	*Dicranella*	*Dicranella*
L. feurichiana	*Bryum*	*Bryum*
L. hanffii	*Dicranella*	*Dicranella*
L. maireana	Pottiaceae	
L. miniata	Pottiaceae	Pottiaceae
L. paechnatzii	*Bryum*	*Bryum*
L. seaveri	*Ceratodon*	*Ceratodon*, *Bryum*
L. spinulosa	*Funaria*?	
L. tuberculata	*Pleuridium*	*Pleuridium*
L. tuberculatella	*Pleuridium*	*Ephemerum*?

? = the relationship is not certain.

Lamprospora prefers a cool environment. Dennis and Itzerott (1973) stated that this group of fungi fruits usually during the winter or early spring. Most collecting dates were recorded in September and October, with a few in April and May. Benkert (1985) also showed that most *L. carbonicola* specimens were collected in October and November. Specimens are usually found in northern parts of the United States. The only southeastern state in the record is Virginia. Only specimens of one related species

O. wrightii (Bk. et Curt.) Mor., were found around Gainesville, Florida during this study.

General morphological characteristics of Lamprospora are as follows (Figs. 1-5): Apothecia are usually very small, ranging from less than 1 mm to 4 mm in diameter, embedded within moss stems or on moss rhizoids; and are sessile or subsessile. The color of the apothecia varies among species but is usually a shade of red, scarlet or brownish red when dry, turning to light orange red or yellowish red when rehydrated. Margins of the apothecium are membranous and fimbriate and usually raised above the hymenium (Fig. 4). The hyphal cells of the margin are clavate, in parallel arrangement (textura porrecta), extending above the hymenium with the free ends forming a fimbriate surface. Rifai (1968) described this type of margin as fimbriate dentate. In a few species, the margin spreads out and curves around the hymenium like flower petals, as in L. ditrichi (Fig. 4), while in L. hanffii (Fig. 5) and L. tuberculatella (Fig. 44), the margin is not so prominent and is at the same level of the hymenial layer. The height of margins is not a reliable taxonomic character. Seaver (1942) did not describe L. areolata as having a raised margin, and Rifai (1968) stated that it does not have raised margins. In this study, I found that the margins of this species are raised. According to Rifai (1968), L. maireana has a raised margin, but from the specimen I

studied, the margin is not high above the hymenial layer. It seems that the margin height is variable among different specimens within the same species.

The surfaces of the apothecia are smooth. No specialized hairs are seen. Many hyphal filaments usually extend out from the bottom giving a tomentose appearance. The surface is usually entangled with soil particles and blue-green algae.

The excipula usually have two layers (Figs. 6-17), one thin hyphal outer layer and a much thicker inner layer. In this paper, this is not interpreted as ectal and medullary excipula as was done by Rifai (1968). The thin hyphal outer layer ranges from 10 to 30 μm in thickness and is composed of interwoven thick walled hyphae (textura intricata) which stain darker in azure blue and cotton blue. Many hyphal hairs grow out from this layer. The thick inner layer constitutes the main portion of the apothecium. Two types of excipular texture were found in this layer among different species. The most common one is composed of polygonal cells (textura angularis), ranging from 10 μm to 50 μm in diameter, (Figs. 6, 7, 9, 10, 12-17) and the other type as in L. arvensis (Fig. 8) and L. ditrichi (Fig. 11), with the excipulum composed of interwoven hyphae (textura intricata), aligned more or less vertically with respect to the apothecial surface, with a hyphal diameter ranging from 6-10 μm. This kind of filamentous excipulum is similar to

Octospora leucoloma (Rifai, 1968). Two species, L. seaveri (Fig. 17) and L. paechnatzii, have a differentiated excipulum. The ectal-excipulum is composed of angular cells and the medullary excipulum is composed of interwoven hyphae. The subhymenium of this group is composed of intricate hyphae of various thickness.

The asci (Fig. 2) in this group are clavate-cylindrical, usually ending with a long stalk, except in L. spinulosa. The length ranges from 150 μm to 370 μm, with the width ranging from 10 μm to 34 μm. The asci are eight-spored; and operculate. The apex does not turn blue in Melzer's reagent. The ascal wall is two layered with the outer layer staining with Congo red and the inner layer with acid fuchsin. The stain characteristics showed no differentiation among species.

The spores (Figs. 18-25, 46-65) are round or slightly subglobose, ranging from 10 μm to 26 μm in diameter. They are hyaline, smooth when immature with gradual development of the ornaments as the spores mature, usually have a large central oil globule inside, which measures 7 μm to 9 μm in diameter. In some cases, this oil globule is divided into a few small globules, which stain light red in Sudan IV. All spores are ornamented, and the ornaments stain deep blue in cotton blue. This character is very helpful in species identification, because many delicate ornaments are revealed by using this staining technique. Before this technique was

developed, Boudier (1907) described the spore of L. carbonicola as smooth walled, and many reticulate spored species were differentiated from L. miniata by using this staining technique. The ornamentation of the spores is divided into four groups and two subgroups: 1). spinose spores (Figs. 21, 61), such as L. spinulosa with blunt spines; 2). tuberculous spores (Figs. 19, 55, 58, 65) with tubercles of various sizes; 3). irregular ridged spores (Fig 45B & C, 62, 64) and 4). reticulate ridged spores (Figs 18, 20, 23-25). The last group (reticulate-spored group) is the most variable, with variability in the size and shape of the ridges and meshes forming the various reticulations. Benkert (1987), according to the shape of mesh, divided the meshes as two types: alveolate mesh, with curved, round-cornered ridges, as in L. hanffii (Figs. 38C & D, 53) and L. seaveri (Figs. 20, 60), and areolate mesh (Figs. 23-25) with straight ridges, usually forming pentagonal or hexagonal meshes, as in L. miniata and L. areolata. An intermediate subgroups can be identified between the tuberculous and the irregular ridged, and another subgroup is between the irregular ridged and the reticulate groups. The former subgroup has large tubercles and ridges (Figs. 22, 45D, 46, 63) and the latter subgroup has ridges forming incomplete reticulations (Fig. 36C, 57). When a 2% KOH solution is added to the slide, most of the ornaments dissolve within 5 to 30 minutes. The spore surface becomes smooth and more

transparent (Figs. 49, 56). This KOH reaction is not a stable character. Pfister (1970) disregarded this character for generic diagnosis. Sometimes, within a slide, most of the spore ornaments dissolved, while a few spores still retained their ornaments.

The paraphyses (Fig. 3) are straight and clavate, 2 μm to 6 μm in diameter, with slightly expanded tips; 6-8 μm in diameter. Occasionally the lower portion of the paraphyses is branched. Many orange granules were seen inside the paraphyses.

Figs. 1-5. General characteristics of Lamprospora. The bar represents 1.3 mm in Fig. 1, 50 μm in Figs. 2 & 3., and 200 μm in Figs. 4 & 5.

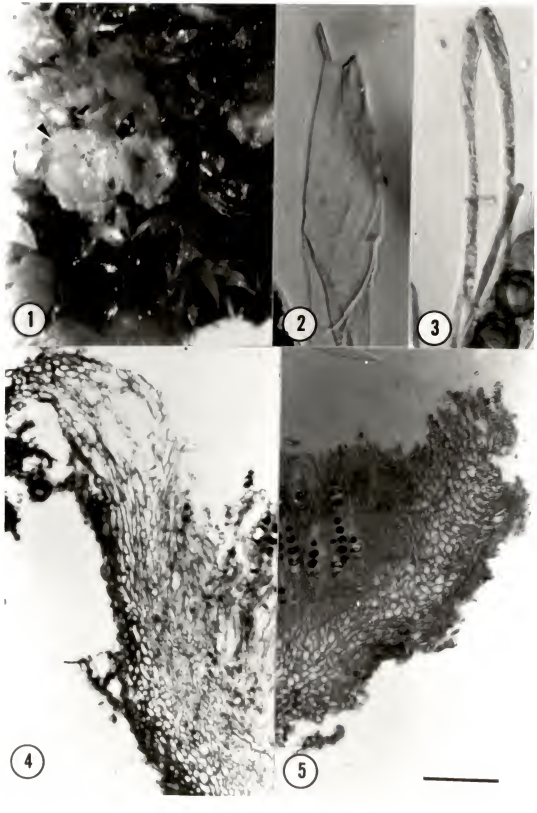
Fig. 1. Apothecia of L. carbonicola, arrow-head pointing to two apothecia.

Fig. 2. An ascal tip of L. areolata showing an operculum .

Fig. 3. Paraphyses tips of L. areolata.

Fig. 4. Apothecial margin of L. ditrichi showing raised margin and excipulum of textura intricata.

Fig. 5. Apothecial margin of L. hanffii showing an unraised margin, and excipulum of textura angularis.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Figs. 6-11. Various excipular textures of Lamprospora species. Figs. 6, 7, 9, & 10 showings excipula of textura angularis. Figs. 8 & 11 showing excipula of textura intricata. The bar represents 100 μm.

Fig. 6. L. areolata.

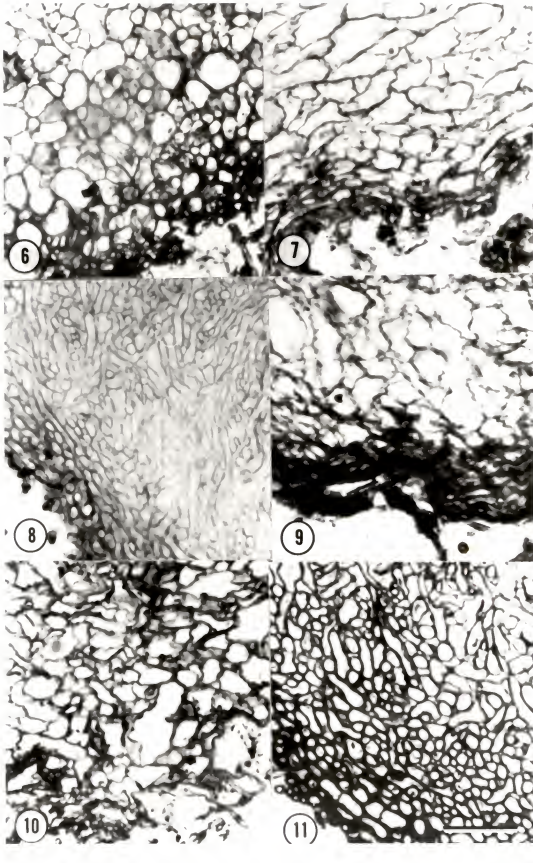
Fig. 7. L. australis.

Fig. 8. L. arvensis.

Fig. 9. L. campylopodis.

Fig. 10. L. carbonicola.

Fig. 11. L. ditrichi.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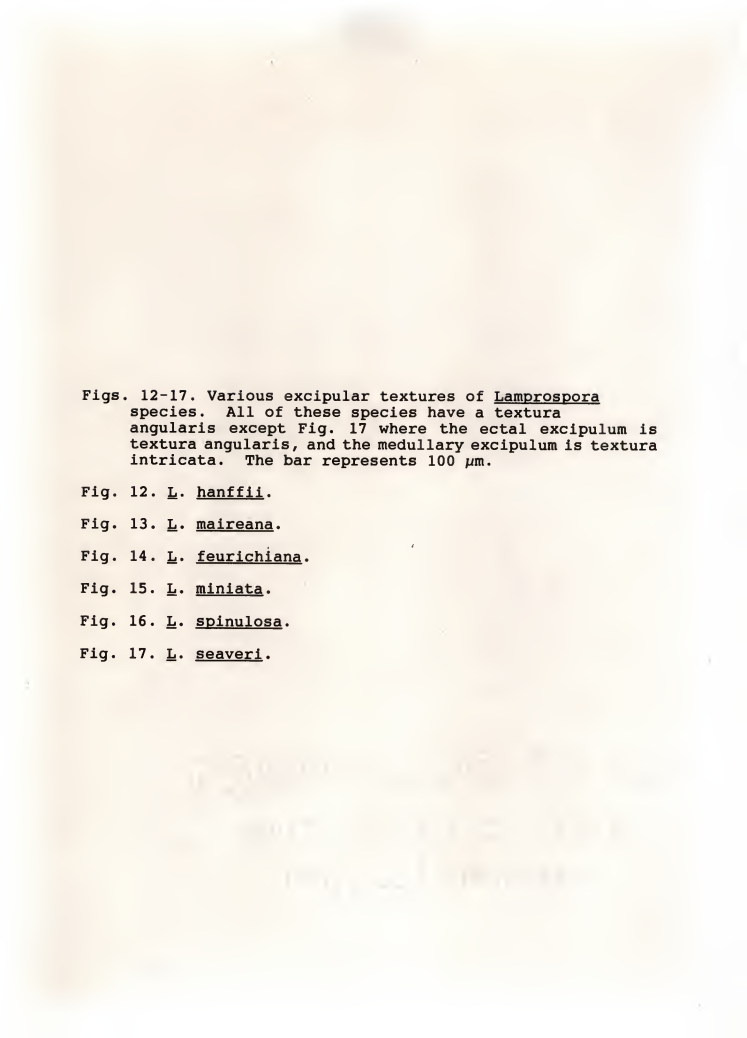


Figs. 12-17. Various excipular textures of Lamprospora species. All of these species have a textura angularis except Fig. 17 where the ectal excipulum is textura angularis, and the medullary excipulum is textura intricata. The bar represents 100 μm.

Fig. 12. L. hanffii.

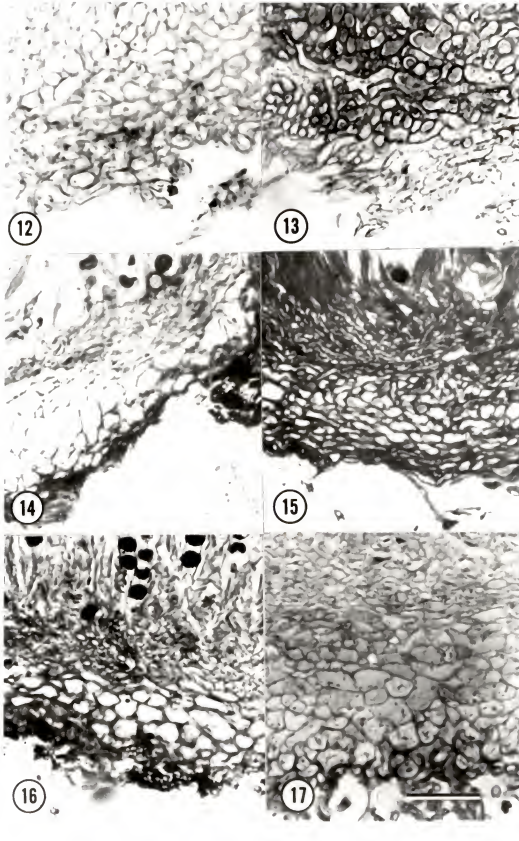
Fig. 13. L. maireana.

Fig. 14. L. feurichiana.

Fig. 15. L. miniata.

Fig. 16. L. spinulosa.

Fig. 17. L. seaveri.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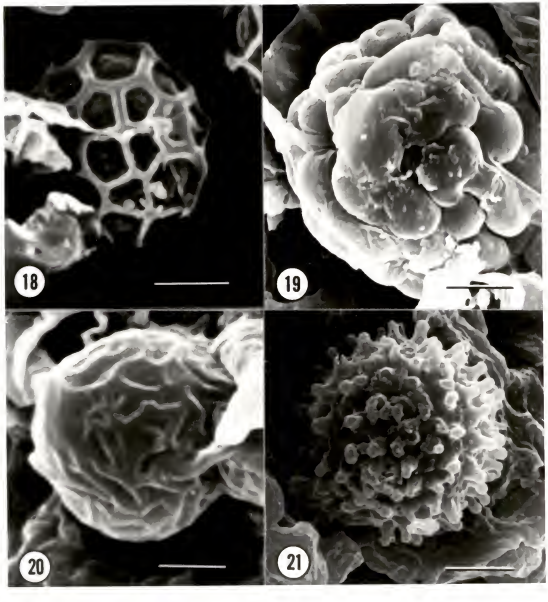
Figs 18-21. SEM photos showing various ornaments of spores. The bar represents 5 μm.

Fig. 18. Reticulate spore of L. feurichiana.

Fig. 19. Tuberculose spore of L. maireana.

Fig. 20. Reticulate spore with alveolate meshes in L. seaveri.

Fig. 21. Spinose spore of L. spinulosa.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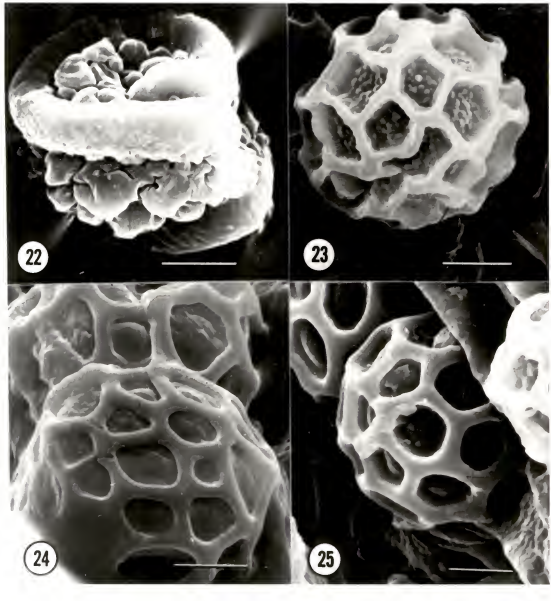
Figs. 22-25. SEM photos showing various ornaments of spores. The bar represents 5 μm.

Fig. 22. Tuberculose spore with ridges in L. annulata.

Fig. 23. Reticulate spore of L. areolata.

Fig. 24. Reticulate spore of L. campylopodis.

Fig. 25. Reticulate spore of L. australis.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CHAPTER 4
PHYLOGENIC RELATIONSHIPS

Lamprospora is similar to Octospora due to its bryophilic habitat, fimbriate apothecial margin, and a thin hyphal outer layer. The former is separated from the latter by the globose versus ellipsoid spore shape and excipular texture of a textura angularis versus intricata. However, three subglobose spored species, L. gotlandica Benk., L. leptodictya Diss., and L. retispora (Itz. & Tha.) Sch., also are included in Lamprospora by Benkert (1987). In this study, the excipular structure of L. arvensis (Fig. 8) and L. ditrichi (Fig. 11) also has been shown to be a textura intricata. Le Gal (1969) and Caillet and Moyne (1980) noted these similarities and merged these two genera into Octospora.

Benkert and Schumacher (1985) transferred three Lamprospora species to Ramsbottomia, a genus established by Buckley (1924). This genus is similar to Lamprospora in having globose, hyaline, ornamented spores, and separated from the latter by soil habitat, a different excipular texture, an even margin, and brownish, hyphoid hairs on the margin. All three genera discussed above have bright orange, small, glabrous apothecia, and hyaline, uniguttulate

spores. The phylogenic relationships among these three genera and within species of Lamprospora were analyzed cladistically in this study.

Cladistic methodology was developed by Hennig (1966), who emphasized that only monophyletic taxa may be regarded as historical groups and recognized in a classification. A monophyletic taxon is defined as a group with a single common ancestor and including all its descendants. This approach to classification has been widely used in zoology and botany, but rarely in mycology. Recently, Tehler (1988, 1989) applied this approach in his investigation of the phylogeny of Eumycota; Morton (1990) used it to discuss the relationships among arbuscular mycorrhizal fungi in the Endogonaceae; Crisci et al. (1988) employed this method to propose a phylogeny for the ascomycete genus Cyttaria; and Kimbrough (unpublished data) applied this methodology to approach the phylogeny of Humariaceae, Pezizales.

Before proceeding with the analysis of Lamprospora, Ramsbottomia and Octospora, I conducted a cladistic analysis of selected genera within Humariaceae, in order to determine the appropriate outgroup.

Analysis of Selected genera within Humariaceae

Taxa: The genera, Peziza Bull. ex St-Aman, Otidea Fuckel, Greletia Donadini, Sphaerosporella (Svr.) Svr. ex

Kur. and Pulvinula Boud., together with Lamprospora, Ramsbottomia, and Octospora, were included in this analysis.

Peziza was selected as an outgroup in this analysis, because Pezizaceae is considered to be a sister group to Humariaceae (Eckblad 1968, Kimbrough 1970). Peziza is characterized by medium to large apothecia with ascal tips that turn blue in Melzer's reagent.

Otidea has medium to large, ear-like apothecia, ellipsoid, smooth spores, and is considered to be a sister genus to Octospora (Kimbrough unpublished data).

Greletia was separated from Marcelleina Rifai by Donadini (1979) because of the habitat difference, spore color and excipular texture. The type species Greletia planchonis (Dun. ex Boud.) Don., was included in Lamprospora by Seaver (1942) due to the globose spores and small apothecia.

Sphaerosporella species are frequently misidentified as Lamprospora species because of spore shape. They are characterized by brown, hairy apothecia, and prominent excipular layers.

Pulvinula has many species that were included in Barlaea, Barlaeina (Saccardo 1898, Rehm 1896), and Lamprospora (Seaver 1942). Pulvinula often is considered to be related to Lamprospora due to its small, bright orange apothecia, and globose spores, and is separated from the

latter by soil habitat, delicate paraphyses, forked ascal bases, and a different excipular texture.

Characters: Eleven characters were selected and the polarity of each character state was decided by comparing it with the outgroup.

1. Habitat: Lamprospora and Octospora are associated with mosses. Most Peziza species are found on soil. Thus, the bryophilic habitat is considered a derived character state, and the soil habitat is considered the plesiomorphic state.

2. Apothecial size: The apothecial diameter of Peziza is usually 2-5 cm. The apothecial size of Lamprospora ranges from less than 1 mm to 5 mm. Apothecial size less than 5 mm is considered a derived state.

3. Apothecial margin: Lamprospora and Octospora have unique fimbriate, membranous margins. The rest of the genera in this analysis have even margins. This fimbriate margin is considered a derived state.

4. Arrangement of marginal cells: The apothecial marginal cells of Ramsbottomia, Octospora, and Lamprospora are elongate and arranged in parallel (textura porrecta). In other genera the marginal cells may expand but not in a parallel arrangement. This well arranged margin is considered an apomorphic state.

5. Apothecial pigment: Pulvinula, Ramsbottomia, Lamprospora and Octospora apothecia have carotenoid pigments. Peziza, Otidea, and Sphaerosporella apothecia are brown while Greletia has dark purple apothecia. Carotenoid pigments are considered an apomorphic state.

6. Apothecial hairs: The apothecia of all genera except Sphaerosporella are smooth. Sphaerosporella has prominent brown, pointed, thick-walled hairs on the outer surface of the apothecia. This hairy condition is considered to be a derived state.

7. Ascal color reaction: Ascal tips that turn blue in Melzer's reagent constitute a very important taxonomic character within Pezizales. Only the ascal tips in Peziza turn blue and this is a key character of this genus. Ascal tips that do not turn blue are treated as derived.

8. Paraphyses tips: The paraphyses tips of Otidea and Pulvinula are curved. The other genera have straight paraphyses. Curved paraphyses are treated as derived from straight paraphyses.

9. Spore shape: Peziza, Otidea and Octospora have ellipsoid spores, other genera in this study have globose spores. Eckblad (1968) suggested that the primitive operculates have ellipsoid, hyaline spores. Globose and subglobose spores are considered derived.

10. Spore surface: Ramsbottomia and Lamprospora have ornamented spores. Although Peziza also has some species

with ornamented spores, smooth spores are considered to be basal within this genus. All young spores of these genera have smooth wall surfaces. Ornamented spores are considered a derived state.

11. Medullary excipular texture: Although the excipulum of Peziza is more complicated than other genera, the medullary excipulum of this genus like most of the other genera has a textura intricata. The excipulum of Ramsbottomia and Lamprospora is of textura angularis, which is considered a derived state.

The character states are summarized in Table 3. The data matrix of these genera is shown in Table 4.

Two equally parsimonious trees of fifteen steps (CI=0.73) were discovered in this analysis, using Hennig86 (Farris 1988). Both trees (Figs. 26, 27) are nearly identical, showing variation only in the clade containing Octospora, Ramsbottomia and Lamprospora. The outgroup is separated from remaining genera by character 7, ascal tip color reaction. Otidea is cladistically basal, with the other genera united by characters 2 and 9, apothecial size and spore shape. Greletia may represent a clade, while Sphareosporella clade is monophyletic, having the autapomorphic character (#8), hairy apothecia. Pulvinula is most closely related to the clade containing Ramsbottomia, Octospora, and Lamprospora with which it shares character 5,

the carotenoid pigment. The last three genera are hypothesized to be a clade based on character 4, elongate marginal cells. Character 8, curved paraphyses, has evolved twice, in Otidea and Pulvinula. As mentioned above, the variable portion of these two trees occurs within the Ramsbottomia, Octospora and Lamprospora clade. In tree A (Fig. 26), Octospora and Lamprospora are sister taxa due to their sharing character 1, bryophilic habitat, and character 3, fimbriate margin. While, in tree B (Fig. 27), Ramsbottomia and Lamprospora, are considered sister taxa due to the shared possession of characters 10, ornamented spores and character 11, the angular excipular texture.

From these results, Pulvinula is considered to be the sister group to the Ramsbottomia-Octospora-Lamprospora clade, and thus, is used as the outgroup for the following cladistic analysis of related species within Ramsbottomia, Octospora and Lamprospora.

Analysis of related species of Ramsbottomia, Octospora and Lamprospora

Taxa: Pulvinula convexella (Kar.) Pfister, the type species of Pulvinula, was used as the outgroup in this analysis. It was included in Barlaeina by Saccardo (1898), but Boudier (1907) and Le Gal (1953) kept it in Pulvinula. Two species of Ramsbottomia, R. macrantha and R.

Crec'hquerault*ii*, were selected to represent this genus. Ramsbottomia macrantha has globose, spiny spores, and R. crec'hquerault*ii* has subglobose, spiny spores. According to Khare (1971, 1978b), twenty-nine species are included in Octospora. Two species, O. leucoloma Hedw. ex Gray, the type species of Octospora, and O. wrightii, were selected for this analysis. Octospora wrightii (Bk. et Curt.) Mor., with subglobose, verrucose spores was included in Lamprospora by Seaver (1942). These five species along with eighteen Lamprospora species were incorporated into this analysis.

Characters: Seventeen characters were selected, and polarized using Pulvinula as the outgroup. These character states are summarized in Table 5, and the data matrix of this analysis is shown in Table 6.

1. Habitat: Species of Pulvinula and Ramsbottomia are found on soil, while Octospora and Lamprospora are associated with mosses. This moss association is considered an apomorphic state.

2. Apothecial margin: The apothecia of Octospora and Lamprospora have membranous, fimbriate margins. Some species have very prominent raised margins, as L. miniata and L. ditrichi (Fig. 4), which may even be curved out like flower petals to surround the hymenium. In a few species the margin is not so obvious and at equal level with the hymenial layer, as L. hanffii (Fig. 5), but still with a

broken appearance. The apothecial margin of Ramsbottomia species is composed of large club-shaped cells, often mixed with brown hyphoid hairs. It is even and curled toward the hymenium layer. In Pulvinula, the marginal cells do not elongate. The fimbriate, membranous margin is considered a derived state.

3. Spore shape: Pulvinula has globose spores. Thus, ellipsoid and subglobose spore shapes are considered as derived from globose spore shape.

4. Spore surface: The young spores of all these species are smooth and ornaments gradually appear on the spore surface during maturity. Pulvinula also has smooth spores. Ornamented spores are considered a derived state.

Since Lamprospora spores contain the most variable and complicated ornamentation within Humariaceae, very few references are available in approaching the transition of spore ornamentation. The stages of spore ornament development (Le Gal 1947, Merkus 1974) are used as principles of polarization. Character 4 to character 14 refer to spore ornamentation. The transition in spore ornamentation and the character coding of each state is shown in Fig. 28.

5. Spinose spore (Figs. 28B & D): In Merkus's (1974) ultrastructure study, the ornaments of R. crec'hqueraultii are different from L. dictydiola (reticulate spore) by having striated structures inside the spines. The spinose

ornaments are considered as one tendency of spore ornamentation.

In Le Gal's (1947) study, the spore ornaments of L. miniata and L. ascoboloides form pustules on the spore surface first, then these pustules gradually connect into ridges. Following the principle of ornament development, three stages are recognized, beginning with tubercles, then to tubercles with ridges, and strict ridges to reticulate (Figs. 28C & E-G). This transition is expressed from characters 6 to 14.

6. Tuberculous spore (Fig. 28C): Three species, L. tuberculata (Figs 43, 58), L. tuberculatella (Figs. 44, 58, 65) and L. maireana (Figs. 19, 39, 55) have various sizes of tubercles on the spore surface. These tubercles are similar to Le Gal's (1947) pustules, and considered the primitive form of spore ornamentations.

7. Tuberculous and ridged spores (Fig. 28E): Two species L. annulata (Figs. 22, 45A, 46) and L. dicranellae (Figs 45D, 63), have both tubercles and ridges on the spore surface. The remaining species have different kinds of ridges on the spore surface. This is considered to be an intermediate state between tuberculous spores and ridged spores.

8. Ridged spores (Fig. 28F): L. ascoboloides (Figs. 45B, 62) and L. paechnatzii (Figs. 45C, 64) have ridged spores and the ridges on the spore surface do not cross to

form reticula. This represents a further developmental stage of spore ornaments.

9. Sharp spines (Fig. 28D): All species of Ramsbottomia have long sharp spines densely distributed on the spore surface. While in L. spinulosa and O. wrightii, spines are short and blunt. Sharp spines is considered a derived state from blunt spines.

10. Reticulate spores (Figs. 28G-J): The ridges cross and begin to form regular reticulations. These reticulate spores are considered as derived from ridged spores.

11. Complete reticulation: Within reticulate spores, some reticula are not completed, as in L. ditrichi (Figs. 28G, 36, 57), which has ridge-breaks between meshes. The complete reticulation is considered as two different derived states developed from incomplete reticulation. These transitional states from incomplete reticulation to complete reticulation are expressed by characters 10 and 11.

12. Alveolate mesh (Fig. 28H): Within reticulate spores, the ridges of L. hanffii (Figs. 38C & D, 53), L. arvensis (Figs. 32C, 50), and L. seaveri (Figs. 20, 41C, 60) are irregularly wide, curved, and form polygonal meshes. These meshes differ in shape and are slightly round at corners. This is considered a synapomorphic character.

13. Areolate mesh (Figs. 28I & J): The rest of the reticulate spores have regular, mostly hexagonal shaped meshes. Although the mesh sizes can be different, from

small as in L. carbonicola (Figs. 35C, 52) to large as in L. campylopodis (Figs. 24, 34C, 48). No gap in these meshes can be found. Thus, mesh size is not selected as a character in this analysis.

14. Ridge ratio: The ridges on L. areolata and L. australis are steep, narrow and high, the ratio (h:w) of these ridges is greater than 2. The ridge ratios of the other species are less than 1. This kind of high ridges (Fig. 28J) is considered a derived state.

15. Outer hyphal layer (Figs. 6-17): Apothecia of both Octospora and Lamprospora have an interwoven hyphal outer layer (textura intricata) with differing thickness. This hyphal outer layer is not seen in Pulvinula and Ramsbottomia. The hyphal outer layer is considered an apomorphic state.

16. Differentiated excipulum: The excipulum of Pulvinula is well differentiated into two layers, an ectal excipulum of a textura angularis, and the medullary excipulum of a textura intricata. Khare (1975) defined the excipulum of O. leucoloma as two layered, with an ectal excipulum of a textura angularis, and a medullary excipulum of a textura intricata. I consider this thin, small celled ectal excipular layer as a hyphal outer layer. Lamprospora paechnatzii and L. seaveri (Figs. 17, 41) have a well differentiated excipulum. The excipula of the other species are uniformly structured. The excipulum with no

differentiation is considered a reduced state from the differentiated excipulum.

17. Excipulum texture: The excipulum of Pulvinula is of a textura angularis. Octospora leucoloma, O. wrightii, L. arvensis (Figs. 8, 32), and L. ditrichi (Figs. 11, 36) have an intricate hyphal excipulum. The presence of intricate hyphal texture is considered to be a derived state.

The data were analyzed using Hennig86 (Farris 1988), and six equal parsimonious trees (length=25, CI=0.68) resulted. One of these six trees (Fig. 29) is presented here along with a strict consensus tree (Fig. 30). In this representative tree (Fig. 29), all species are separated from the outgroup by character 4, ornamented spore surface, and character 16, an undifferentiated excipulum. Ramsbottomia crec'hqueraultii and R. macrantha form a clade by having spinose spores (characters 5 and 9), which is a sister group to a clade containing all other species. The latter clade is supported by character 1, bryophilic habitat, character 2, fimbriate margin and character 15, excipulum with an hyphal outer layer. Note that character 5, shows homoplasy (Fig. 29) and that character 4, smooth spore, is reversed in O. leucoloma. The transition in spore ornamentation (Figs. 28, 29, see characters 4-16) shows an hypothesis regarding phylogenic relationship among the species of Lamprospora. The reticulate-spored species form

a monophyletic group within this genus. Character 16, differentiated excipulum, is reversed in L. seaveri and L. paechnatzii. Character 17, intricate hyphal texture, evolves in parallel in L. ditrichi and L. arvensis. The variable portion among these six trees (Figs. 29, 30) is among L. spinulosa, the species of Octospora, and the three tuberculous-spored species. Other portions are identical in the six trees. From the consensus tree (Fig. 30) and the representative cladogram (Fig. 29), it is evident that Ramsbottomia is a monophyletic group, separated from Octospora and Lamprospora by three characters. In contrast, Lamprospora is not a monophyletic group (i.e., it is a paraphyletic group) and shares a common ancestor with Octospora. Characters 3, ellipsoidal spores, is a synapomorphic character of Octospora, however, the shared possession of globose spores in Lamprospora is symplesiomorphic.

All other clades within Lamprospora are closely related to each other. Lamprospora tuberculata, L. tuberculatella and L. maireana are in one clade. These three species all have tuberculous spores, and are considered to be the sister group to other species due to their simple spore ornamentation. Lamprospora annulata and L. dicranellae both have tubercles and ridges on the spore surface and are considered as derived from the tuberculous group. After this clade, starting from the L. ascoboloides and L.

paechnatzii group, tubercles disappear and various ridges appear on spore surfaces. Lamprospora ditrichi has incompletely reticulate spores, and is considered as a member of the sister group of all reticulate-spored species. Two subclades are recognized within reticulate-spored species; one branch leads to the L. seaveri, L. hanffii, and L. arvensis clade, which has various alveolate meshes, and apothecial textures. The other branch leads to species with areolate-meshed spores. The latter is unified by regular meshed spores, and angular-celled excipular texture. Mesh size shows continuous increase, from less than 2 μm in L. carbonicola, to as large as 6 μm in L. campylopodis. The most prominent ridges in this group are found in L. areolata and L. australis, and the excipulum is composed of large angular cells and a thin hyphal outer layer. Most species of Tuberales, considered an advanced group within ascomycetes (Eckblad 1968, Korf 1973), also have this kind of prominent reticulate spores.

From the results above, I agree with Benkert's (1987) transfer of certain species to Ramsbottomia, which now is hypothesized as a monophyletic sister group of Lamprospora and Octospora. I also agree with Le Gal's (1969) idea that Lamprospora cannot be separated from Octospora, and thus should be merged into Octospora. The cladistic results indicate that Lamprospora would be paraphyletic if segregated from Octospora. Together, these genera comprise

a monophyletic group. An emendation of Octospora to accommodate the other species of Lamprospora is made in the following chapter.

It is common in Pezizales that some genera have both smooth and ornamented, or globose and ellipsoid spored species in the same genus. Many genera, Marcelleina Rifai, Ascobolus Pers., and Boudiera Cooke, have smooth and ornamented spored species (Korf 1972). Ascodesmis Tiegh, Ascobolus Pers., Tricophaea Boud., and Scutellinia (Cooke) Lam. have both globose and ellipsoid spored species (Korf 1972).

Many genera have been considered to be related to Octospora. Khare (1971, 1978b), while working on Indian Octospora species, combined Octospora, Byssonectria Karst. and Kotlabaea Svr. (Svrček 1969) into Octospora, and treated these three genera as subgenera. However, he considered that the marginal excipular texture and spore shape did not permit clear distinction among these three genera. Khare also had a broad definition of Octospora, with the hymenial color varying from creamy white to red, deep violet to brownish black. The characteristic of bryophilic habitat was neglected. Both the type species of Byssonectria, B. fusispora (Berk.) Roger. et Korf, and the type species of Kotlabaea, K. deformis (Karst.) Svr., were found on soil (Khare 1971). Dennis and Itzerott (1973), while working on western European bryophilic fungal species, divided the

orange-disked bryophilic Humariaceae into two genera, Octospora and Inermisia Rifai. Two species of Leucoscypha Boud. emend. Rifai were transferred into Octospora, based on the bryophilic habitat and ellipsoid spore shape, but the characteristic of hairy apothecia was discounted. More detailed studies to include cladistic analyses among these genera are needed to alleviate the taxonomic confusion.

Table 3. Characters used in cladistic analysis of the selected genera within Humariaceae.

Plesiomorphic	Apomorphic
1. non-bryophilic	bryophilic
2. apothecia greater than 5.0 mm	apothecia not greater than 5.0 mm
3. apothecial margin even	margin fimbriate
4. edge cells not elongate	edge cells elongate
5. contain no carotenoid pigments	contain carotenoid pigments
6. glabrous	hairy
7. asci tip turns blue	does not turn blue
8. paraphysis tip not curved	tip curved
9. spores ellipsoid	spores globose; subglobose
10. spore surface smooth	spore surface ornamented
11. medullary excipulum of a textura intricata	medullary excipulum of a textura angularis

Table 4. Data matrix for the cladistic analysis of selected genera within Humariaceae 0=plesiomorphic, 1=apomorphic.

Genus	Character										
	1	2	3	4	5	6	7	8	9	10	11
Peziza	0	0	0	0	0	0	0	0	0	0	0
Otidea	0	0	0	0	0	0	1	1	0	0	0
Greletia	0	1	0	0	0	0	1	0	1	0	0
Lamprospora	1	1	1	1	1	0	1	0	1	1	1
Octospora	1	1	1	1	1	0	1	0	0	0	0
Pulvinula	0	1	0	0	1	0	1	1	1	0	0
Ramsbottomia	0	1	0	1	1	0	1	0	1	1	1
Sphaerosporella	0	1	0	0	0	1	1	0	1	0	0

Table 5. Apomorphic characters used in cladistic analysis of Lamprospora, Octospora, and Ramsbottomia.

	Plesiomorphic	Apomorphic
1.	non-bryophilic	bryophilic
2.	apothecial margin even	margin fimbriate
3.	spore globose,subglobose	spore ellipsoid,
4.	spore smooth	spore ornamented
5.	tuberculous, ridged spore	spinose spore
6.	spinose, ridged spore	tuberculous spore
7.	tuberculous, spinose spore	ridged and warty spore
8.	ridged and warty spore	ridged spore
9.	blunt spine	sharp spine
10.	ridged spore	reticulate spore
11.	ridge interbroken	ridge continuous
12.	other form	alveolate mesh
13.	other form	areolate mesh
14.	ridge ratio (h/w) not greater than 2.0	ridge ratio (h/w) greater than 2.0
15.	excipulum without outer layer	with outer layer
16.	excipulum differentiated	not differentiated
17.	excipulum of a textura angularis	excipulum of a textura intricata

Table 6. Data matrix for the cladistic analysis of *Lamprospora* *Octospora*, and *Ramsbottomia*. 0=plesiomorphic, 1=apomorphic, ?=missing data.

Taxon	Character																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pulvinula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. macrantha	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1	0
R. crec'hqueraultii	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0
O. leucoloma	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1
O. wrightii	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1
L. annulata	1	1	0	1	0	0	1	0	0	0	0	0	0	0	?	1	0
L. areolata	1	1	0	1	0	0	1	1	0	1	1	0	1	1	1	1	0
L. arvensis	1	1	0	1	0	0	1	1	0	1	1	1	0	0	1	1	1
L. ascoboloides	1	1	0	1	0	0	1	1	0	0	0	0	0	0	1	1	0
L. australis	1	1	0	1	0	0	1	1	0	1	1	0	1	1	1	1	0
L. campylopodis	1	1	0	1	0	0	1	1	0	1	1	0	1	0	1	1	0
L. carbonicola	1	1	0	1	0	0	1	1	0	1	1	0	1	0	1	1	0
L. dicranellae	1	1	0	1	0	0	1	0	0	0	0	0	0	0	?	1	0
L. ditrichi	1	1	0	1	0	0	1	1	0	1	0	0	0	0	1	1	1
L. feurichiana	1	1	0	1	0	0	1	1	0	1	1	0	1	0	1	1	0
L. hanffii	1	1	0	1	0	0	1	1	0	1	1	1	0	0	1	1	0
L. maireana	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0
L. miniata	1	1	0	1	0	0	1	1	0	1	1	0	1	0	1	1	0
L. paechnatzii	1	1	0	1	0	0	1	1	0	0	0	0	0	0	?	0	0
L. seaveri	1	1	0	1	0	0	1	1	0	1	1	1	0	0	1	0	0
L. spinulosa	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0
L. tuberculata	1	1	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0
L. tuberculatella	1	1	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0

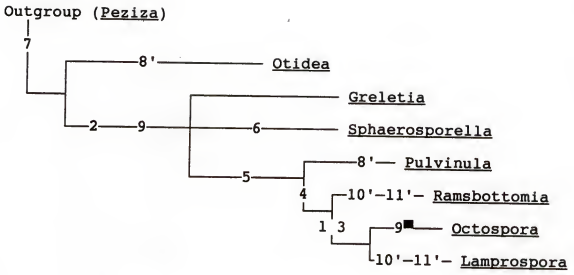


Fig. 26. Tree A from a cladistic analysis of selected genera within Humariaceae.
' parallelism; ■ reversal.

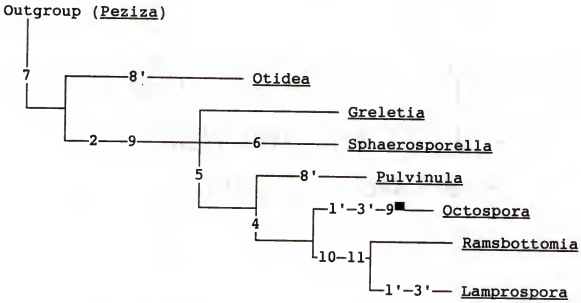
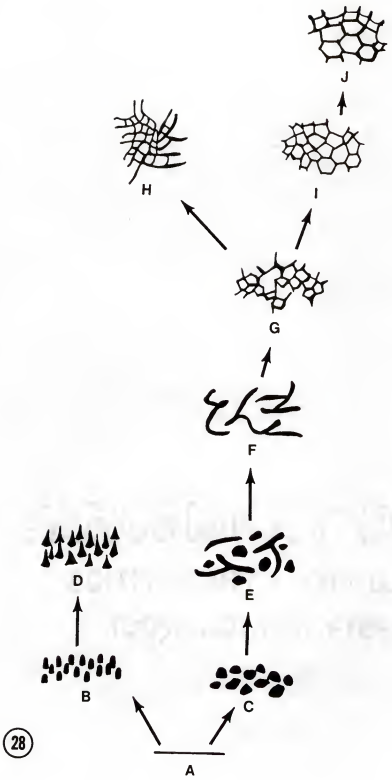


Fig. 27. Tree B from a cladistic analysis of selected genera within Humariaceae.
' parallelism; ■ reversal.

Fig. 28. Transition in spore ornamentation. Character coding (characters 4-14) of each state is listed. States B to D and E to J, H are considered ordered.

	#4	5	6	7	8	9	10	11	12	13	14
A). Smooth walled.	0	0	0	0	0	0	0	0	0	0	0
B). Blunt spines.	1	1	0	0	0	0	0	0	0	0	0
C). Tubercules.	1	0	1	0	0	0	0	0	0	0	0
D). Sharp spines.	1	1	0	0	0	1	0	0	0	0	0
E). Warts and ridges.	1	0	0	1	0	0	0	0	0	0	0
F). Ridges.	1	0	0	1	1	0	0	0	0	0	0
G). Incomplete reticulum.	1	0	0	1	1	0	1	0	0	0	0
H). Alveolate meshes.	1	0	0	1	1	0	1	1	1	0	0
I). Areolate meshes.	1	0	0	1	1	0	1	1	0	1	0
J). Areolate meshes with prominent ridges.	1	0	0	1	1	0	1	1	0	1	1



28

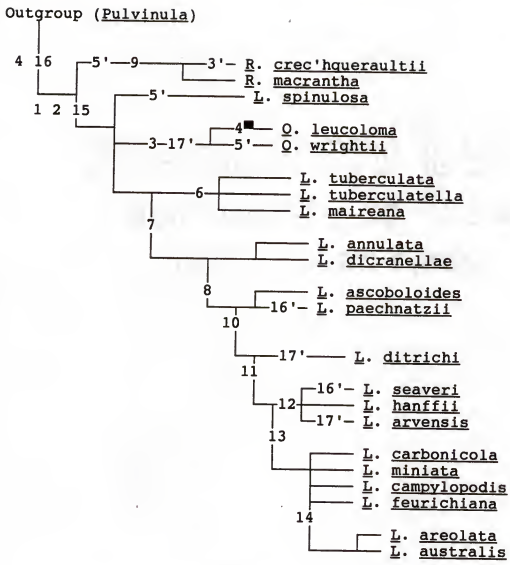


Fig. 29. One of six trees from cladistic analysis of Lamprospora, Octospora, and Ramsbottomia. ' parallelism; ■ reversal.

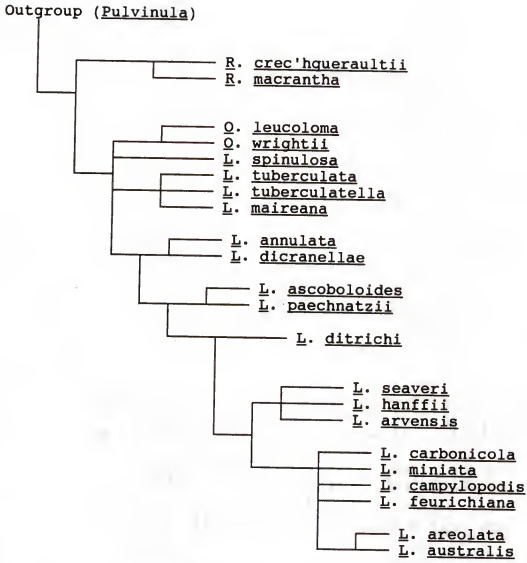


Fig. 30. Consensus tree of six trees from cladistic analysis of Lamprospora, Octospora, and Ramsbottomia.

CHAPTER 5
TAXONOMIC TREATMENT

Octospora Hedw. ex Gray emended Wang

Octospora Hedw., Descr. Musc. frond. 2: 4. 1789.

Octospora Hedw. ex Gray., Natural Arrangement of British Plants 1: 666. 1821, emend. Korf, Mycologia 46: 838. 1954.

Peziza (Dill.) St-Amans "div." Discina Fr."Ser".Aleuria Fr. "trib". Humaria Fr., Syst. Mycol. 2: 42. 1822.

Humaria (Fr.) Boud., Bull. Soc. Mycol. Fr. 1: 106. 1885; non Humaria Fuckel. Jb. Nassau Ver. Naturk. 23-24: 320. 1870. emend. Sacc. Bot. Cbl. 18: 216. 1884. [=Scutellinia (Cooke) Lamb.]; nec Humaria Fuckel. emend. Korf in Nagaoa 7: 4. 1960. (=Mycolachnea Maire).

Leucoloma Fckl., Jb. Nassau. Ver. Naturk. 23-24: 317. 1870; non Leucoloma Brid., Bryol. Univ. 2: 218. 1827.

Humaria Seaver, Mycologia 19: 87. 1927. (nomen nudum). Humaria Seaver ex Seaver., North. Am. Cup-Fungi (oper.) 121. 1928.

Lamprospora De Not., Commentario Soc. Critt. Ital. 1: 388. 1864.

Crouania Fuckel., Jb. nassau. Ver. Naturk. 23-24: 320. 1870; non Crouania Agardh, Alg. Mar. medit. adr. 83. 1842. (=Algae). Peziza (Dill.) St-Amans subgen. Crouania (Fckl.) Sacc. Bot. Cbl. 18: 218. 1884. Humaria (Fr.) Boud. [sect.] Crouania Cooke, Handb. Austral. Fungi 256. 1892.

Barlaea Sacc., Syll. Fung. 8: 111. 1889 (a name change); non Barlaea Reichenb. f. Linnaea 41: 54. 1877. (=Orchidaceae).

Barlaeina Sacc., Tab. comp. Gen. Fung. 30. 1898. (a name change); non Barlaeina Sacc. emend. Le Gal Revue Mycol. 18: 80. 1953.

Apothecia bryophilic, small, less than 10 mm, sessile, discoid to shallow cupulate, fleshy, externally glabrous or finely tomentose, with membranous fimbriate margin. Hymenium yellow, orange, or red. Excipulum of a thin outer layer of textura intricata, and a thick layer of textura angularis or intricata. Asci 8-spored, operculate, cylindrical to subclavate with long or short base; non-amyloid. Spores hyaline, globose, subglobose to ellipsoid, guttulate, smooth, spinose, tuberculous, ridged, or reticulate. Paraphyses straight or slightly curved, septate, with carotenoid granules in the upper part.

Key To The Species

Spores globose:

1a. Spore ornaments composed of spines, tubercles or tubercles with ridges ..... 2.

1b. Spore ornaments composed of anastomosing or nonanastomosing ridges ..... 7.

2a. Spores spinose, spines blunt, 1.0-1.6 μm high ..... O. spinulosa.

2b. Spores tuberculous or tubercles and ridged ..... 3.

3a. Spore ornaments with tubercles and ridges ..... 4.

3b. Spore ornaments only with tubercles ..... 5.

4a. Spore ornaments with tubercles and two polar annual bands ..... O. annulata.

4b. Spore ornaments with tubercles and ridges, irregularly distributed on spore surface ..... O. dicranellae.

5a. Spore tubercles with interior globules ... O. maireana.

5b. Spore tubercles without modification ..... 6.

6a. Spore tubercles small, less than 2.0 μm in diam. ... . O. tuberculatella.

6b. Spore tubercles large, greater than 2.5 μm .... O. tuberculata.

7a. Spore ridges end abruptly, not forming a reticulum.. 8.

7b. Spores reticulate, with various meshes ..... 9.

8a. Spore ridges wide, 1.5-2.0 μm in diam. O. ascoboloides.

8b. Spore ridges curved, narrow, 0.5-1.0 μm in diam. .....

..... O. paechnatzii.

9a. Spore ridges interbroken, 0.5-0.8 μm in width, reticulum not complete ..... O. ditrichi.

9b. Spore ridges continuous, forming complete reticulum.10.

10a. Spore ridges straight, forming regular polygonal meshes (areolate)..... 13.

10b. Spore ridges curved, forming variable shaped meshes (alveolate)..... 11.

11a. Spore ridges wide, 1.6-2.4 μm in diam., excipulum of textura intricata..... O. arvensis.

11b. Spore ridges narrow, 0.5-0.8 μm in diam., excipulum of textura angularis ..... 12.

12a. Spore meshes, 2.0-4.0 μm in diam., apothecial margin not obvious..... O. hanffii.

12b. Spore meshes with various shape, reticula overlapped forming secondary reticulation ..... O. seaveri.

13a. Spore ridge height less than 0.8 μm. ..... 14.

13b. Spore ridge height greater than 0.8 μm ..... 17.

14a. Spore ridges very fine, 0.3-0.5 μm wide, mesh less than 2 μm in diam. ..... O. carbonicola.

14b. Spore ridges 0.5-1.0 μm wide, mesh 2.0-4.0 μm in diam. spore 14-16 μm in diam. ..... O. miniata.

15a. Spore ridge height less than 2.0 μm, ratio (h:w) less than 2.0 ..... 16.

15b. Spore ridge height greater than 2.0 μm, ratio (h:w) greater than 2.0, flanges around spore..... 17.

16a. Spore ridges 0.8-1.0 μm high, mesh 3-6 μm in diam., excipulum reduced ..... O. feurichiana.

16b. Spore ridges 0.8-1.6 μm high, mesh 4-6 μm in diam., spore 18-20 μm in diam. ..... O. campylopodis.

17a. Spore ridges 1.6-2.4 μm high, apothecium less than 1.0 mm in diam. ..... O. areolata.

17b. Spore ridges 2.0-3.2 μm high, apothecium greater than 1.0 mm in diam. ..... O. australis.

Spores ellipsoid: see Le Gal (1969), Khare (1971), and Caillet and Moyne (1980) for species traditionally placed in Octospora.

Species Description

Specimens from various herbaria were examined; all were accessioned as Lamprospora unless otherwise designated.

Octospora annulata (Seaver) Wang comb. nov.
(Figs. 22, 45A, 46)

≡ Lamprospora annulata Seaver, Mycologia 6: 11. 1914.

= L. biannulata Beauseigneur in Grelet, Rev. Mycol. 10: 115. 1945.

≡ O. biannulata (Beau.) Caillet et Moyne, Bull. Soc. Mycol. France. 96: 180. 1980.

Apothecia of this species were not found. Only preserved slides were examined in this study. Seaver (1942, p.60) described the apothecia as " Apothecia gregarious but not crowded, at first subglobose and nesting in little cavities in the substratum, expanding and becoming discoid or subdiscoid, pale-orange, reaching a diameter of 0.5-1 mm; hymenium becoming plane or nearly plane and more or less pitted or roughened, a little darker than the outside of the apothecium." Excipulum of a textura angularis to textura globulosa, polygonal cells 10-16 x 10-20 μm. Asci 8-spored, clavate-cylindrical, not blueing in Melzer's Reagent, 20 x 200 μm. Ascospores uniseriate, globose, hyaline, uniguttulate, or with more than two guttules, (14-)16-18 μm; tuberculous; tubercles 2-3 μm wide, with two prominent polar annular bands, band 3-6 μm in diam., sometimes two bands interconnected. Ornaments do not dissolve in 2 % KOH within 30 minutes. Paraphyses clavate, 2-4 μm, simple, gradually extend at the apex up to 6-8 μm.

Habitat: On soil among algae and moss; only soil with a few moss stems were found in the packets, and the moss was identified as Campylium radicale in one specimen. Benkert (1987) cited the associated moss genus as Pleuridium for the European species.

Type locality: Portland, Connecticut, USA.

Specimens examined: United States Connecticut: Portland, Aug. 1913, F. J. Seaver (NY; holotype); Oct. 1913, F. J.

Seaver (NY). New York: New York City, Oct. 29, 1913, F. J. Seaver (NY); Yonkers, Jun. 25, 1914, F. J. Seaver (NY); West Mount Vernon, Aug. 27, 1914, F. J. Seaver (NY).

Comments:

All specimens of O. annulata examined were from the herbarium of the New York Botanical Garden. The spore ornamentation is similar to O. dicranellae by having tubercles and ridges, but the former has only two polar ridges. The tubercles are similar to those of O. tuberculata; however, the size of tubercles is larger in the latter.

In Svrček's (1976) examination of Velenovský's specimens of Barlaea melina, he cited it as a synonym for L. annulata Seaver. Benkert (1987) agreed with his citing of B. melina as the synonym for L. annulata. Velenovský's (1934) illustration, however, shows that spores of B. melina are tuberculous but without prominent polar rings. This spore is more similar to the L. tuberculata than L. annulata. Based on these observations, I reject Svrček's synonym, B. melina.

Drawings of Beauseigneur's specimens of L. biannulata with two polar bands on the spore surface indicate that it is synonymous with O. annulata. Since the epithet annulata has priority, it is used in this paper.

Octospora areolata (Seaver) Wang comb. nov.

(Figs. 2, 3, 6, 23, 31, 51)

≡ Lamprospora areolata Seaver, Mycologia 4: 48. 1912.

Apothecia discoid to cupulate, 0.5-1 mm in diam., hymenium light yellow when dry, receptacle surface darker than the hymenium, margin slightly raised, outer surface closely attached with algae and moss. Excipulum two layered, outer layer of textura intricata, 20-30 μm thick, stain darker than inner layer, thick walled hyphal cell 6-10 μm in diam., wall 2 μm thick, many hyphal hairs growing from this outer layer; inner layer of textura angularis, polygonal cells 16-30 x 20-40 μm, axes of cells perpendicular to the outer surface, total thickness 260 μm; margin are composed of parallel arranged hyphal cells, a textura porrecta, cells elongated, 6 x 20 μm, giving the fimbriate appearance. Subhymenium of textura intricata, 60 μm thick, hyphae 4-6 μm in diam. Hymenium 240 μm thick. Asci 8-spored, clavate-cylindrical, not turning blue in Melzer's reagent, 18-22 x 190-250 μm. Ascospores uniseriate, hyaline, globose, uniguttulate, reticulate, (12-)14-16 μm in diam., (16-)18-20(-22) μm include the marking. Spore marked with high ridges, 0.8 x 3.2-4.0 μm, connected into reticulation, flanges shown around spores under microscope, meshes mostly hexagonal 4-8 μm in diam., 4-6 meshes per spore diam. Markings do not dissolve in 2% KOH

within 30 minutes. Paraphyses subclavate, septate, 3-4 μm in diam., slightly expanded at apex up to 6-8 μm.

Habitat: On soil among mosses. The mosses in these packets were identified as Funaria sp.

Type locality: Yonkers, New York, USA.

Specimens examined: United States New York: Bronx, New York Botanical Garden, Sept. 1912, F. J. Seaver (NY); New York City, summer, 1912, F. J. Seaver (NY); Sept. 1912, F. J. Seaver (NY); Yonkers, Aug. 12, 1911, F. J. Seaver (NY; holotype); Westchester, Pelham, Oct. 1912, F. J. Seaver (NY).

Comments:

Although Seaver (1942) did not mention a raised margin for Lamprospora areolata, the present study found a raised margin high above the hymenium for this species. This species and O. australis both have prominent narrow ridges on the spore surfaces which look like flanges around spore edges under the light microscope. Benkert (1987) described this kind of ridge as having striations on both sides. It differs from O. australis by the smaller apothecia, and the meshes on spores surface are more irregular than that of the latter.

Octospora arvensis (Velen.) Wang comb. nov. (Figs. 8, 32, 50)

≡ Barlaea arvensis Velen., Mon. Disc. Boh. 323. 1934.

≡ Lamprospora arvensis (Velen.) Svr., Sborn. Mus. Nár. Praze. 32: 126. 1976.

Apothecia discoid, 1-4 mm in diam., hymenium orange yellow, receptacle smooth with raised fimbriate margin, outer surface colonized with blue-green algae. Excipulum of textura intricata, outer layer thick 40-60 μm, thick walled hyphae 4-6 μm in diam., wall thickness 2 μm. staining deep blue in cotton blue or azure blue. Many hyphal hairs grow from the outermost layer. Toward the central part, hyphae swollen, 6-8 μm in diam., arranged vertically to the axis of the apothecium, total thickness 280 μm. In the margin, cells lined up (textura porrecta), free ends form the fimbriate margin. Margin raised above hymenium 140 μm, cells 6-10 x 20 μm. Subhymenium of textura intricata, 60-80 μm thick, hyphae 4-6 μm in diam. Hymenium 320 μm thick. Asci 8-spored, cylindrical, not turning blue in Melzer's Reagent, wall thick 0.8 μm, 20-26 x 234-270 μm, filled with granules when young. These granules stain strongly in cotton blue, but disappear at spore maturity. Ascospores uniseriate, globose, hyaline, uniguttulate, reticulate, (12-)14-16 μm in diam., (14-)16-18(-20) μm including the markings; spores marked with wide curved ridges, width of the ridge varies from 1.6-2.4 μm, height 0.8-2.0 μm, ridges do not completely dissolve in 2% KOH within 30 min. Paraphyses subclavate, simple, 4 μm in diam., slightly expanded at apex, 6-8 μm in diam.

Habitat: On moss Ceratodon purpureus

Type locality: Bohemia, Czechoslovakia.

Specimen examined: United States Michigan: Ann Arbor, Apr. 17, 1930, A. H. Smith (MICH; as L. areolata).

Comments:

Svrček (1976), in his revision of Velenoský's collection, renamed this species as L. arvensis. It is characterized by wide ridges, round alveolate meshes and a textura intricata excipulum. The specimen from MICH was misidentified as L. areolata, but the wider and irregular curved ridges differentiate it from the latter. The diameter of the spore is smaller than Svrček's description. None of the previous descriptions mentioned the special texture of the excipulum.

Octospora ascoboloides (Seaver) Caillet et Moyne, Bull. Myc. France. 96: 180. 1980. (Figs. 45B, 62)

≡ Lamprospora ascoboloides Seaver, Mycologia 4: 10. 1912.

No apothecia were found in the herbarium specimens; description of asci and spores are based on preserved slides. Seaver (1942, p.60) described the apothecium as: "Apothecia gregarious, at first globose and closed, nesting in little depressions in the substratum, gradually expanding and becoming discoid or subdiscoid, externally slightly floccose, usually not exceeding 1 mm in diameter, pale-

orange; hymenium at first concave, becoming plane and finally convex, roughened by the protruding asci." **Excipulum** of textura angularis, polygonal cells 12-24 x 20-50 µm. **Asci** 8-spored, clavate-cylindrical, 14-16 µm wide, not turning blue in Melzer's reagent. **Ascospores** uniseriate, globose, hyaline, 12-14(-16) µm, (14-)16-18 µm including ornaments, marked with irregular curved ridges, ridges 0.8-2.4 µm wide, 0.8-1.6 µm high.

Habitat: Among moss, Dicranella sp.

Type locality: Portland, Connecticut, USA.

Specimens examined: United States Connecticut: Oct. 12, 1915, F. J. Seaver (NY); Portland, Sept. 1912, F. J. Seaver (NY; holotype). New York: New York City, Oct. 15, 1915, F. J. Seaver (NY); Yonkers, Sept. 16, 1912, F. J. Seaver (NY); Westchester, Pelham, Oct. 1912, F. J. Seaver (NY). Virginia: Clarke, White Post, Sept. 1911, B. O. Dodge (NY; as Barlaea ascoboloides).

Comments:

The epithet of this species is derived from Ascobolus because of the resemblance of their spore ornamentation. The ridges on spore surface are curved, rarely crossed or branched. The ornamentation is similar to that of O. dicranella but without warts.

Octospora australis (McLen. & Cooks.) Wang comb. nov. (Figs. 7, 25, 33, 47)

≡ L. areolata Seaver var. australis McLennan & Cookson, Proc. Roy. Soc. Victoria II 35: 155. 1923.

≡ L. australis (McLen. & Cooks.) Rifai, Verh. Kon. Ned. Akad. Wetensch. Afd. Natuurk. II. 57: 182. 1968.

Apothecia discoid, 2-3 mm in diam., with fimbriate margin, hymenium light yellow when dry, receptacle darker than the hymenium, bottom tomentose. **Excipulum** two layered, outer layer of textura intricata, cell diam. 6-12 μm, 30 μm thick, staining darker than inner portion; inner layer of textura angularis, polygonal cells, 10-24 x 14-50 μm, total thickness 260 μm, margin cells parallel, a textura porrecta, free ends form the fimbriate margin, 10 x 30 μm in diam.; margin 60 μm high above hymenium, **Subhymenium** of textura intricata, 100 μm thick, hyphae 4-6 μm in diam. **Hymenium** 340 μm thick. **Asci** 8-spored, cylindrical, not turning blue in Melzer's reagent, 18-22 x 250-300, with croziers at their bases. **Ascospore** uniseriate, hyaline, globose, uniguttulate, reticulate (13-)16-18 μm in diam., 18-20(-24) μm, including ornamentation; spores marked with high ridges 1.6-2.4 μm high, 0.5-0.8 μm wide, forming a prominent reticulation. Flanges surround the spore edge, mesh 3-6 μm in diam., 4-6 meshes per spore diam., markings dissolved in 2% KOH within 10 min. **Paraphyses** subclavate, straight, 3-4 μm in diam., slightly expanded on the apex up to 6 μm.

Habitat: Among the moss Campylopus introflexus.

Type locality: Victoria, Australia.

Specimen examined: Australia New South Wales, Aug. 19, 1981, W. B. Buck (NY).

Comments:

This Australian species was erected by Rifai (1968) from L. areolata var. australis based on larger apothecia, distinctive fimbriate margins, and a small and delicate secondary spore reticulum. Rifai (1968) stated that L. australis has a secondary reticulum on the spore surface. In this study, no secondary reticulation was observed in spores of O. australis under scanning electron microscope (Fig. 25). However, the ridges on the spore surface in this species are straighter than those of O. areolata.

Octospora campylopodis (Buck.) Wang comb. nov.

(Figs. 9, 24, 34, 48, 49)

≡ L. campylopodis Buckley, Trans. Brit. Mycol. Soc. 9: 44. 1924.

Apothecia discoid with a short stalk, hymenium brightly orange red, 1-2 mm in diam., receptacle with prominent fimbriate raised margin, darker than the hymenium. Excipulum two layered, outer layer of textura intricata, 40 μm thick, hyphal cell diam. 6-10 μm, thick walled, stain darker than inner part; inner layer of textura angularis,

large polygonal cells 10-320 x 12-46 μm; total thickness 220 μm, cells elongate toward margin, and are parallel (textura porrecta), free ends forming the fimbriate margin. Margin 120 μm high above hymenium, then curved out like flower petals, cells 4 x 20 μm. Subhymenium of textura intricata, 60 μm thick, hyphae 4 μm in diam. Hymenium 280 μm thick. Asci 8-spored, clavate-cylindrical, tapering down into a long stem base, do not turn blue in Melzer's reagent, 20-24 x 220-320 μm. Ascospores uniseriate, hyaline, globose, uniguttulate, (14-)16-18 μm in diam., 18-22(-24) μm, including ornaments; spores marked with ridges 1.0-1.6 μm wide, 1.0 μm high, forming reticulations, mesh 1.6-6.4 μm in diam., 4-7 meshes per spore diam., markings dissolved in 2% KOH within 5 min. Paraphyses straight, 3-4 μm in diam., slightly extended at the apex up to 6-7 μm in diam.

Habitat: Among the moss Campylopus pyriformis

Type locality: Scotland, United Kingdom.

Specimens examined: United Kingdom England: Ascot Heath, Beckshire. 1863, C. E. Broome (NY; FH, Rabenhorst, Fungi eur.#658. as Ascobolus miniatus); Wiltshire, Bathford, no date, C. E. Broome (DAOM; Rab. Fungi eur. #658. as Ascobolus vinosus). United States New York: New York City, Oct. 24, 1913, F. J. Seaver (NY; two packets, as L. miniata).

Comments:

Rifai (1968) described L. miniata according to Rabenhorst's fungi no. 658, A. miniatus, and stated that

Cooke's (1864) description was also based on this collection. Benkert (1987) examined the same specimen and assigned those specimens to L. campylopodis Buck. After reexamining the same material in Rab. Fungi. eur. #658, I agree with Benkert's designation that this should be treated as O. campylopodis. Benkert (1987) described the ridges on the spore surface in this species as punctate ridges, with punctations along two sides of the ridge. This phenomenon is not obvious with the light microscope, and is not seen under SEM (Fig. 24). Spore ornamentation in this species is similar to O. miniata, but the apothecium is smaller, the spore size is larger and the ridges on spore surfaces are wider and higher than those of the latter.

A specimen from NY was annotated by Benkert in 1985 as L. aff. campylopodis. Spores of this species are small (14-16 μm, 18-20 μm including ornamentation), and it is associated with two different mosses, Bryum caespiticum and Ceratodon purpureus.

Octospora carbonicola (Boud.) Wang comb. nov.
(Figs. 1, 10, 35, 52)

≡ Lamprospora carbonicola Boud., Hist. Class. Discom. 68. 1907.

= Lamprospora polytrichi (Schum.) Le Gal, Bull. Soc. Mycol. France 56: 39-45. 1940.

Apothecia discoid, sessile, 1-4 mm in diam., hymenium yellow orange, receptacle lighter than hymenium, with raised fimbriate margin; bottom with many hyphal hairs, entangled with moss rhizoids and soil particles. **Excipulum** of textura angularis, large polygonal cells, 10-30 x 20-50 µm, thick 200 µm, marginal cells elongate, 10-24 x 30-40 µm, arranged parallel (textura porrecta), free ends form fimbriate margin, margin 180 µm high above hymenium. **Subhymenium** of textura intricata to textura globosa, 20-50 µm thick, hyphal cells 2 µm in diam. **Hymenium** 200 µm thick. **Asci** 8-spored, clavate-cylindrical, do not turn blue in Melzer's reagent, with croziers at base, 10-18 x 120-180 µm. **Ascospores** uniseriate, hyaline, globose, uniguttulate, (10-)14-16(-18) µm in diam., reticulate; spores marked with fine ridges, less than 0.5 µm wide, forming delicate reticulations, mesh 1-3 µm in diam., 7-11 meshes per spore diam. Markings dissolve in 2% KOH within 30 minutes. **Paraphyses** straight to curved, with granules, 3-4 µm in diam., apex gradually extend to 6 µm.

Habitat: Among the moss Funaria hygrometrica

Type locality: Montmorency, France.

Specimens examined: France Bois du Fréhaut, Meurthe et Moselle, Mar. 1907, R. Maire (NY, CUP#12041, FH, MICH, and BPI, as L. dictydiola); Germany Berlin, Pteglitz, Oct. 1894, P. Sydow (NY; as Barlaea polytrichina); Jena, Arnstadt, Jonastal, SW der Stadt, Brandstelle an einem

Waldweg ca. 500 m östl. vom Löbchen. May 15, 1980, K. -F. Günter (CUP #60548; as Lamprospora dictydiola). United Kingdom England: Worcestershire, Oct. 19, 1928. C. Rea (BPI). United States Iowa: Iowa City, Spring, 1905, F.J. Seaver (BPI; as Barlaea miniata); Iowa City, May 22, 1905, F. J. Seaver (CUP #538; as L. astroidea). Michigan: Ann Arbor, May 7,1907, C. H. Kauffman (MICH; as L.dictydiola); Chelsea, Sugar Loaf Lake, May 19, 1912, C. H. Kauffman (MICH; as L. crouani); Washington County, May 8, 1907, C.H. Kauffman (CUP #5183,as L. astroidea). New York: New York City, May 31, 1917, F. J. Seaver (NY; as L. dictydiola); New York City, Long Island, no date, B. O. Dodge & F. J. Seaver (NY; as Barlaea miniata). West Virginia: West Morgantown, Apr. 22, 1907, W. J. Durand (BPI; as Barlaea miniata); Apr. 22, 1907, J. L. Shelder (CUP #6511, as L. astroidea); On burnt ground, no collecting place, Oct. 1913, F. J. Seaver (NY; as L. dictydiola).

Comments:

The reticulation on spore surfaces in this species is very fine and is not obvious without staining. Boudier (1907) described it as smooth, but Le Gal (1940) found the reticulation by staining with cotton blue. This species is characterized by large apothecia and very fine reticulations. It is associated with Funaria hygrometrica.

All synonyms are based on the association with Funaria hygrometrica and delicate reticulation on spore surfaces.

In Fuckel's (1870) original description, the C. carbonaria which Benkert (1987) considered synonymous with L. carbonicola has reticulate spores. Seaver (1942) described L. carbonaria as having round smooth spores with curved paraphyses, often found on burnt ground. Pfister (1976) examined Fuckel's fungi rhenani #2482 and transferred L. carbonaria to Pulvinula carbonaria (Fckl.) Boud. Seaver's description of the NY specimens fit those of Pulvinula carbonaria. Le Gal (1940) transferred L. polytrichi from Peziza polytrichi Schum., which had usually been related to Leucoscypha rutilans and L. vivida and associated with Polytrichum. Caillet and Moyne (1980) considered L. polytrichi and L. carbonicola to be synonymous. To avoid confusion, I have followed Benkert's (1987) opinion to use the specific epithet carbonicola.

Octospora dicranellae (Benk.) Wang comb. nov. (Figs. 45D, 63)

≡ Lamprospora dicranellae Benkert, Z. Mykol. 53: 217. 1987.

Only a fragment of an apothecium was found and it is in bad condition. The description was made mainly from preserved slides. Benkert (1987, p.217) described the apothecium as: "Apothecium about 3 mm wide, with distinct membranous margin. Hymenium orange. Excipulum of textura

angularis, margin of textura porrecta, subhymenium of textura intricata." Asci 8-spored clavate-cylindrical, 16-18 x 200 μm, do not turn blue in Melzer's reagent, with elongate stem bases. Ascospores globose, hyaline, uniguttulate, 14-16(-17) μm in diam. spore ornamented with irregular ridges and warts, ridges 0.8-1.6(-2.0) μm wide, 0.8-1.0 μm high. Warts of various sizes, 0.8-2.4 μm in diam. Paraphyses clavate, simple, 2-4 μm in diam. slightly expanded in tip, up to 4-6 μm.

Habitat: Among the moss Dicranella.

Type locality: Bohemia, Czechoslovakia.

Specimens examined: United States New York: Bronx, New York Botanical Garden, Nov. 13, 1913, F. J. Seaver (NY; as Lamprospora ascoboloides); Bronx River Parkway, Oct. 8, 1918, F. J. Seaver (NY; as L. ascoboloides); West Mount Vernon, Sept. 30, 1913, F.J. Seaver (NY).

Comment:

The spore ornamentation in this species is different from O. ascoboloides, by having various warts. The apothecium is also larger in the former. It is considered that this species genealogically rests between the tuberculous-spored and ridged-spored groups.

Octospora ditrichi (Benk.) Wang comb. nov.

(Figs. 4, 11, 36, 57)

≡ Lamprospora ditrichi Benkert, Z. Mykol. 53: 221. 1987.

Apothecia discoid, 1-2 mm in diam., hymenium orange red, receptacle lighter than hymenium, with raised, fimbriate margin. Excipulum two layered, outer layer of textura intricata, hyphal cells 4-6 µm in diam., stain darker than inner layer, layer 40 µm thick; inner layer of textura intricata, cell up to 6-12 µm diam. total thickness 240 µm, marginal cells arranged parallel (a textura porrecta), 10 x 30-40 µm, margin 160 µm high above hymenium. Subhymenium of a textura intricata, 100 µm thick, hyphae 4-6 µm in diam. Hymenium 300 µm thick. Asci 8-spored, clavate-cylindrical, do not turn blue in Melzer's reagent, 18-30 x 210 µm. Ascospores uniseriate, hyaline, globose, 14-16(-18) µm in diam., reticulate, spore marked with ridges, 0.5-0.8 µm wide, forming a delicate reticulum, sometimes reticulations are not complete, but become warts or big spots, mesh size 1.6-4 µm in diam., 7-11 meshes per spore diam., ornaments dissolve in 2% KOH within 30 min. Paraphyses straight, 4 µm in diam., slightly expanded at the apex, up to 6-8 µm in diam.

Habitat: On soil but associated with the moss Ditrichum flexicaule

Type locality: Västergötland, Sweden.

Specimens examined: Sweden Väskergotland: Österplana, Oct. 21, 1942. N. Albertson (DAOM #66771; as L. Crouani). United

States Alaska, Beechey Point Quadrangle, W. R. Buck #8903, (NY; as L. dictydiola).

Comments:

This species is similar to O. miniata on the basis of the spore ornamentation, but the meshes are often not complete. The associated moss and excipular texture are also different from those of the latter. The specific epithet ditrichi is based on the associated moss Ditrichum sp.

Octospora feurichiana (Kirs.) Wang comb. nov.
(Figs. 14, 18, 37, 54)

≡ Barlaeina feurichiana Kirs., Ann. Mycol. 33: 205. 1935.

≡ Lamprospora feurichiana (Kirs.) Benkert, Feddes reper. 17: 639. 1976.

= Detonia dictyospora Clements & Clements, unpublished name on herbarium specimens (NY, CUP).

Apothecia discoid, less than 1 mm in diam., hymenium orange red, receptacle lighter than hymenium, with fimbriate margin. Excipulum two layered, outer layer of textura intricata, very thin, 14 μm thick; hyphal cell 4-6 μm; inner layer of a textura angularis, very reduced, 70-90 μm thick, only few layers of large polygonal cells, 14-36 x 24-40 μm, cells elongating form the fimbriate margin, margin 60 μm high above hymenium, cells 6-8 x 30-50 μm. Subhymenium of a

textura intricata, 40 μm thick, hyphae 4 μm in diam. **Hymenium** 220 μm thick. **Asci** 8-spored, clavate-cylindrical, do not turn blue in Melzer's reagent, 14-18 x 144-150 μm. **Ascospores** uniseriate, hyaline, globose, uniguttulate, 14-18 μm in diam., reticulate, ridges 0.8-1.0 μm high, 0.5-0.8 μm wide, mesh 1.6-8 μm in diam., 3-7 meshes per spore diam. **Paraphyses** straight, 4 μm in diam.

Habitat: Among mosses, Bryum sp.

Type locality: Oberlausitz, Germany.

Specimens examined: United States. Colorado: Beaver Dam 2700 m, Aug. 18, 1904, Clements and Clements (NY, CUP #116, #5295; as Detonia dictyospora).

Comments:

The reticulation of spore ornamentation is similar to O. miniata, but the ridges are higher and mesh size is larger than in the latter. The excipulum of the apothecium is reduced to only a few cell layers. The origin of the name Detonia dictyospora was not discovered. It was not even explained in Clement and Shear's (1931) book, but the specimens under this name in NY and CUP fit the description of L. feurichiana.

Octospora hanffii (Benk.) Wang comb. nov. (Figs. 5, 12, 38, 53)

≡ Lamprospora hanffii Benkert, Z. Mykol. 53: 225. 1987.

Apothecia discoid, 0.5-1.0 mm in diam., hymenium orange yellow, receptacle lighter than hymenium, margin is not raised. **Excipulum** two layered, outer layer of textura intricata, hyphal cells 4-10 μm, layer 40 μm thick, many interwoven hyphal hairs grow from this layer; inner layer of textura angularis, polygonal cell axes perpendicular to the outer surface, 6-20 x 6-40 μm, layer 200 μm thick. Marginal cells slightly elongate, closely attached to each other, 8-16 x 10-16 μm. **Subhymenium** of a textura intricata, 40 μm thick, hyphae 6 μm in diam. **Hymenium** 240 μm thick. **Asci** 8-spored, clavate-cylindrical, do not turn blue in Melzer's reagent, 15-20 x 200-270 μm, with elongate bases. **Ascospores** uniseriate, globose, hyaline, uniguttulate, 14-16(-18) μm in diam., reticulate, ridges 0.5-0.8 μm wide, with secondary reticulations inside meshes, alveolate mesh 1.6-3.2 μm in diam., ornaments dissolve in 2% KOH within 30 min. **Paraphyses** straight, 4 μm in diam., slightly expanded at the apex, up to 6 μm.

Habitat: Associated with the moss, Dicranella cerviculata.

Type locality: Annaberg, Germany.

Specimens examined: Germany. Annaberg: Fichtelberg, Sept. 22, 1986, D. Benkert (FLAS; isotype).

Comments:

Spore ornamentation of this species is similar to that of O. carbonicola, but the reticulation is more complicated, ridges are irregular in width, forming alveolate meshes. The apothecial margin is not raised.

Octospora maireana (Seaver) Wang comb. nov.

(Figs. 13, 19, 39, 55, 56)

≡ Lamprospora maireana Seaver, Mycologia 6: 14. 1914.

Apothecia discoid, subsessile, hymenium orange red, 1-2 mm in diam., receptacle darker than hymenium, with fimbriate raised margins. Excipulum two layered, outer layer of textura porrecta, hyphae irregularly arranged, 6-8 μm in diam. layer 40 μm thick; inner layer of textura angularis, 100 μm thick, polygonal cells 6-14 x 6-20 μm, elongate at the margin, 8 x 40 μm forming the fimbriate margin. Subhymenium of a textura intricata, 100 μm thick, hyphae 4-6 μm in diam. Hymenium 300 μm thick. Asci 8-spored, clavate, 26-34 x 280-370 μm; apex do not turn blue in Melzer's reagent, with many globules in the epiplasm. Ascospores uniseriate, globose, hyaline, 18-22(-24) μm in diam., (20-)22-26 μm including ornaments, tuberculous, tubercles 3.2-4.8 x 1.6-3.2 μm, with many small interior guttules forming a foamy appearance, ornaments dissolve in 2% KOH within 5 min. Paraphyses straight, 4-6 μm, gradually expanded at the apex up to 8-10 μm.

Habitat: Associated with liverwort, Fossowbronia sp. and moss species of Pottiaceae.

Type locality: Algiers, Algeria.

Specimens examined: Algeria Algiers, Jan. 2, 1912, R. Maire (NY, BPI, isotype, as L. tuberculata). United States New York: New York City. New York, Oct. 29, 1913. F. J. Seaver (NY). Virginia: Clarke, White Post, Sept. 1911, B. O. Dodge (NY).

Comments:

This species has the largest spores and asci in Lamprospora. The spore ornaments are very unique, having many interior guttules, and they dissolve rapidly in 2% KOH. The shape of the tubercles is irregular. (Fig. 19). This species is named after Dr. R. Maire who found the type specimen in Africa.

Octospora miniata (De Not.) Caillet et Moyne, Bull. Soc. Mycol. France. 96: 180. 1980. (Figs. 15, 40, 59)

≡ Ascobolus miniatus Cr., Ann. Sci. Nat. 10: 197. 1858. (non Preuss, Linnaea 24: 147)

≡ Lamprospora miniata De Not., Comm. Soc. Critt. Ital. 1: 338. 1863.

≡ Crouania miniata (Cr.) Fuckel, Symb. Myc. 320. 1869.

≡ Barlaea miniata (Cr.) Saccardo, Syll. Fung. 8: 111. 1889.

≡ Plicariella miniata (Cr.) Lindau, E & P. Nat. Pfl. I,1: 180. 1897.

= Ascobolus crouani Cooke, J. Bot. 2: 151. 1864.

≡ Peziza crouani (Cke.) Cooke, Grevillea. 3: 31. 1874.

≡ Aleuria crouani (Cke.) Gillet, Champ. France. Discom. 50. 1879.

≡ Crouania crouani (Cke.) Lambotte, Flor. Mycol. Belg. 319. 1880.

≡ Humaria crouani (Cke.) Quélet, Enchir. Fung. 288. 1886.

≡ Lamprospora crouani (Cke.) Seaver, Mycologia 6: 8. 1914.

Apothecia discoid, bright red, 1-2 mm in diam., receptacle darker than hymenium, with prominent fimbriate margin, bottom with many hyphal hairs. Excipulum two layered, outer layer of textura intricata, hyphae 6-8 μm in diam., layer 10 μm thick; inner layer of textura angularis, polygonal cells 6-14 x 8-28 μm, marginal cells elongate, free ends forming fimbriate margin, margin 120 μm high above hymenium, cells 8-10 x 30-40 μm. Subhymenium of textura intricata, 40 μm thick, hyphae 4 μm in diam. Hymenium 320 μm thick. Asci 8-spored, clavate-cylindrical, tips do not turn blue in Melzer's reagent, 18-22 x 200-300 μm. Ascospores uniseriate, globose, hyaline, uniguttulate, (14-)16-18(-20) μm in diam., spore reticulate, ridges 0.5-0.8 μm wide, 0.5-0.8 μm high, areolate meshes 1.0-6.0 μm in diam., 5-10 meshes per spore diam., ornaments do not dissolve in 2

% KOH within 30 min. Paraphyses straight, simple, 4 μm in diam., gradually expanded at the apex, 6-8 μm in diam.

Habitat: On soil among the mosses, Trichostomum and Bryum. Benkert (1987) cited the associated moss as belonging to the Pottiaceae.

Type locality: Brest, France.

Specimens examined: Bermuda Elbow Beach, Jan. 28, 1926, F. J. Seaver and H. H. Whetzel (NY, CUP #34634); Feb. 3, 1926, F. J. Seaver and H. H. Whetzel (NY, CUP #34637). France Herb. Patouillard, (FH; as Humaria Crouani); Herb. Patouillard, No date, Angers (FH; as Peziza crouani and Crouania miniata) Norway Finnmark Fylke, Varangerbotn, Aug. 20, 1978, S. Sivertsen, H. Dissing & R. P. Korf (CUP# 59232). United Kingdom England, Richmond, Kew, Royal Botanical Garden, Oct. 25, 1958, J. L. Gilbert (DAOM #88854); Elevellacei, Britannici, no date, W. Phillips (CUP #111091; as Peziza crouani); Yorks, From the Herbarium of Massee, no collecting date (NY; as Barlaea crouania). United States Colorado: Aug. 24-26, 1910, F. J. Seaver and E. Bethel (NY; as Barlaea miniata). New York: Bronx, New York Botanical Garden, Jun. 6, 1916, F. J. Seaver (NY; as L. crouani); New York Botanical Garden, Oct. 22, 1915, F. J. Seaver (NY). May 1915, F. J. Seaver (NY).

Comments:

The spore reticulation in this species is similar to O. campylopodis but with smaller spore size and less prominent

ridges. This is the type species of Lamprospora. All the names cited above are considered as synonymous for A. miniatus. The oldest specific epithet for this species should be miniata.

Octospora paechnatzii (Benk.) Wang comb. nov. (Figs. 45C, 64)

≡ Lamprospora paechnatzii Benkert, Z. Mykol. 53: 237. 1987.

Only slides of this species were found. The description is based on the slides. Benkert (1987, p.237) described the apothecium as following: "Apothecia 1-2 mm wide, with membranous margin. Hymenium yellow to light orange. Ecto-excipulum of textura globulosa-angularis, cells small; endo-excipulum of textura intricata, margin of textura porrecta." Asci 8-spored, clavate-cylindrical, tip do not turn blue in Melzer's reagent. Ascospores globose, hyaline, (14-)16-17 μm in diameter, ornamented with irregular ridges, ridge 0.5-0.8 μm wide, about 0.5 μm high. These ridges rarely cross to each other.

Habitat: Among Bryum sp.

Type locality: Bernau, Germany.

Specimens examined: United States New York: Bronx, New York Botanical Garden, Mar. 11, 1912, F. J. Seaver (NY; as L.

miniata); New York City, Van Courtlandt Park, Sept. 24, 1906. F. J. Seaver (NY; Barlaea ascoboloides).

Comments:

Benkert (1987) considered the spore ornamentation of this species as very similar to that of O. ascoboloides. He differentiated these species by stating that the ridges of O. paechnatzii are narrower and shallower than those of O. ascoboloides. In the present study, the spore ornamentation of O. paechnatzii shows more similarity to that of O. seaveri. These two species can be differentiated by the loose distribution of the ridges on the spore surface in the latter species.

Octospora seaveri (Benk.) Wang comb. nov. (Figs. 17, 20, 41, 60)

≡Lamprospora seaveri Benkert, Z. Mykol. 53: 241. 1987.

Apothecia discoid, 1-2 mm, orange red, receptacle lighter than hymenium, with fimbriate margin. **Ectal-excipulum** two layered, outer layer of textura intricata, hyphae 6-8 μm in diam., layer 20 μm thick; inner layer of textura angularis, 100-120 μm thick, polygonal cells, 8-14 x 10-16 μm, many hyphal hairs grow from the outer surface giving a tomentose appearance. **Medullary excipulum** of textura intricata, hyphal cell 6-8 in diam, mixed with subhymenium, layer 100 μm thick. Marginal cells elongate,

free ends forming the fimbriate margin. Hymenium 240 μm thick. Asci 8-spored, rarely 5-6 spored at maturity, clavate-cylindrical, not turning blue in Melzer's reagent, with long stalks, wall 1 μm thick. Ascospores uniseriate, globose, hyaline, uniguttulate, (12-)14-16(-18) μm in diam., ridges 0.8 μm wide, curved and connected into irregular reticulations, sometimes with a secondary reticulum inside meshes. Ornaments dissolve in 2% KOH within 30 min. Paraphyses straight, slightly expanded at the apex, 6 μm in diam.

Habitat: Among plants of the moss, Ceratodon purpureus

Type locality: Potsdam, Germany.

Specimens examined: Germany Potsdam: Bahndammböschung am Berlinger Aussenring an Rande des Kieskutenberg beim Nesselgrund. Nov. 23, 1986, D. Benkert (FLAS; isotype). United States Iowa: Iowa City. Sept. 6, 1926, G. W. Martino (NY; as L. laetirubra).

Comments:

This species is characterized by various shaped alveolate meshes, and the excipulum is differentiated into ectal and medullary zones.

Cooke (1879) used the epithet laetirubra to substitute Crouania cinnabarina Fckl. when he transferred this species to Peziza. Legarde (1906) later transferred Peziza laetirubra to Lamprospora, and his drawing shows that this is a reticulate-spored species. Although Seaver (1942)

examined Fuckel's Crouania cinnabarina specimen in Fungi rhenani no. 2481 and found it to have smooth spores, he (1942) described L. laetirubra as characterized by a coarse, loose reticulation. Rifai (1968) and Pfister (1976) examined Fuckel's same slide, and identified it as a species of Pulvinula. Pfister (1976) invalidated the name Lamprospora laetirubra. Benkert (1987) proposed L. seaveri to accommodate his European specimens and Seaver's North American specimens of Lamprospora laetirubra. I accept Benkert's nomenclature for this species. A close epithet laeterubra is used by Pfister (1976) for Pulvinula laeterubra to accommodate Lamprospora wisconsinensis Seaver (see discussion in excluded species under L. wisconsinensis).

Octospora spinulosa (Seaver) Wang comb. nov. (Figs. 16, 21, 42, 61)

≡Lamprospora spinulosa Seaver, Mycologia 6: 11. 1914.

Apothecia discoid, less than 1 mm in diam., hymenium orange yellow, many hyphal hairs grow from beneath the receptacle and entangled with algae, with a fimbriate raised margin. Excipulum two layered, outer layer of textura intricata, hyphal cells 6-8 μm, layer 20 μm thick; inner layer of textura angularis, 40-50 μm thick, small polygonal cells, 8-20 x 10-24 μm in diam., margin of textura porrecta,

raised 60 μm above hymenium. Subhymenium of textura intricata, 70 μm thick, hyphae 6-8 μm in diam. Hymenium 200 μm thick. Asci 8-spored, short clavate, spores almost filling whole asci, tips not turning blue in Melzer's reagent, 18-20 x 150-200 μm. Ascospores uniseriate, globose, hyaline, (12-)14-16(-18) μm in diam., (13-)16-20(-22) μm including ornaments, spinose, blunt spines, 1.0-1.6 x 1.0 μm, ornaments do not dissolve in 2% KOH within 30 min. Paraphyses straight, 2-3 μm in diam., slightly expanded at the apex up to 6 μm in diam.

Habitat: Among plants of the moss, Funaria sp.

Type locality: Bronx, New York, USA.

Specimens examined: India Mussoorie, Aug. 25, 1952. L. R. Batra (CUP IN-21). United States Iowa: Iowa City, Sept. 2, 1929. M. Cecelia (NY). New York: Bronx, New York Botanical Garden, York, Sep. 1912, F.J. Seaver (NY; holotype); New York Botanical Garden, Oct. 25, 1915, F. J. Seaver (NY); New York City, Summer 1912, F. J. Seaver (NY; isotype); Pelham, Oct. 1912. F.J. Seaver (NY; five packets); Scardale, Sept. 18, 1914. D. Wilson and F. J. Seaver (NY); Yonkers, New York, Oct. 1912. F.J. Seaver (NY); Jun. 18, 1914, F. J. Seaver (NY).

Comments:

Spores of this species have blunt spines densely distributed on spore surface. Benkert (1987), however, did not mention this species in his description of the genus

Lamprospora. In this study, according to the bryophilic habitat, fimbriate marginate apothecia, and globose spores, I transferred it to Octospora.

Octospora tuberculata (Seaver) Caillet & Moyne, Bull. Soc. Mycol. France. 96: 180. 1980. (Figs. 43, 58)

≡ Lamprospora tuberculata Seaver, Mycologia 4: 27. 1912.

Apothecia orange red, buried in substrate, margin not raised, discoid, 0.5-1 mm in diameter. **Excipulum** two layered, outer layer of textura intricata, hyphal 4-6 μm in diam., layer 10 μm thick; inner layer of textura angularis, 40 μm thick, small polygonal cells, 8-10 x 10-20 μm, marginal cells elongate, lined parallel (textura porrecta), 6-10 x 14-30 μm, free ends forming a fimbriate margin. **Subhymenium** of textura intricata, 20 μm thick. **Hymenium** 170 μm thick. **Asci** 8-spored, clavate, tips do not turn blue in Melzer's reagent, 20-21 x 220-230 μm. **Ascospores** uniseriate, globose, hyaline, 16-18 μm, (19-)20-22 μm including ornaments, tuberculous, tubercles (1.6-)3.2-4.0(-5.6) μm wide, 1.6-3.2 μm high. **Paraphyses** straight, clavate, 2-4 μm in diameter, slightly expanded at the tip up to 5 μm.

Habitat: On soil among plants of the moss, Pleuridium sp.

Type locality: Yonkers, New York, USA.

Specimens examined: United States New Jersey: Aug. 1911. B. O. Dodge and F. J. Seaver (NY). New York: Bronx, New York Botanical Garden, New York, Nov. 18, 1913. F. J. Seaver (NY); Yonkers, July, 21, 1911, F. J. Seaver (NY; holotype, as Barlaea tuberculata); Oct. 16, 1911. F. J. Seaver (NY); July, 1912, F. J. Seaver (NY); Sept. 1912, F. J. Seaver (NY); Oct. 1915, F. J. Seaver (NY); New York City, July 24, 1914, F. J. Seaver (NY); July 21, 1911. F. J. Seaver (NY); Pelham, Oct. 1912, F.J. Seaver (NY). West Mount Vernon, Sept. 30, 1913. F. J. Seaver (NY).

Comments:

According to Seaver's drawing (1942), the apothecium has a slightly raised margin. In this study, the apothecial margin of this species is not raised. The spore ornaments are similar to that of O. maireana but without the interior globules.

Octospora tuberculatella (Seaver) Caillet & Moyne. Bull. Soc. Mycol. France. 96: 180. 1980. (Figs. 44, 65)

≡Lamprospora tuberculatella Seaver, Mycologia 6: 15. 1914.

Apothecia discoid, light orange, embedded in substrate, 0.5-1 mm in diam., fimbriate margin not raised, bottom colonized with blue-green algae. Excipulum two layered, outer layer of textura intricata, hyphae 6 μm in diam., layer 10 μm thick; inner layer of textura angularis-

globulosa, 40 μm thick, small polygonal cells 6-12 x 12-24 μm, marginal cells elongate, parallel arranged (textura porrecta), 6-8 x 20 μm, free ends forming the fimbriate margin. Subhymenium textura intricata, 30 μm thick. Hymenium 300 μm thick. Asci 8-spored, clavate-cylindrical, tips do not turn blue in Melzer's reagent. Ascospore uniseriate, globose, hyaline, uniguttulate, (12-)14-16(-18)μm, 16-18(-20) μm including ornaments, tuberculous, tubercles (0.8-)1.6-2.4 μm wide, 0.8-1.6 μm high. Paraphyses straight, clavate, 2-4 μm in diameter, expanded at the tips, up to 6 μm.

Habitat: On soil among plants of the moss, Pleuridium sp.

Type locality: Yonkers, New York, USA.

Specimens examined: United States New York: Bronx, New York Botanical Garden, Oct. 1912. F. J. Seaver (NY, two packets); July, 31, 1913. F. J. Seaver (NY); Yonkers, Sept. 1912, F.J. Seaver (NY; holotype); New York, Sept. 16, 1912, F.J. Seaver (NY); Local Fungi, no date, F. J. Seaver (NY); Virginia: Clarke, White Post, Sept. 1911, B. O. D. Dodge (NY; as Barlaea sp.).

Comments:

The spore ornamentation is similar to O. tuberculata, but the tubercles are smaller and more distantly spaced than those of the latter. A specimen from NY under Lamprospora tuberculatella collected by Thaxter (Maine, September 1914), which has spinose spore. The point of the spine is

difficult to observe without staining. The diameter of the spine is larger than those of O. spinulosa and are more distantly distributed on the spore surface. Benkert (1987) assigned this specimen to L. tuberculatella. At this time, I cannot assign it. Further investigation may confirm it to be a new species.

Doubtful and Excluded Species

Barlaea alba Velenovský, Mon. Disc. Boh. 321. 1934.

= Pulvinula alba (Velen.) Svrcek, Ces. Mykol. 31: 70. 1977.

This species is characterized by white apothecia, globose smooth spores and curved paraphyses. It is a species of Pulvinula.

Barlaea globifera (Berk. & Curt.) Sacc., Syll. fung. 8: 112. 1889.

≡ Pulvinula globifera (Berk. & Curt.) Le Gal, Prodr. Flore. Mycol. Madagascar 4: 94. 1953.

Because of the soil habitat, globose smooth spores and delicate paraphyses, this should be a species of Pulvinula.

Barlaea lacunosa Ellis & Ev., Proc. Acad. Nat. Sci. Phila. 347. 1942.

≡ Pithya lacunosa (Ellis & Ev.) Seaver, North. Am. Cup-Fungi. 77. 1942.

This species is usually found on the bark or foliage of Abies. It could not be a species of Octospora

Barlaea macrospora Velenovský, Mon. Disc. Boh. 323. 1934.

≡ Svrcekia macrospora (Velen.) Kubička, Ces. Mykol. 14: 214-218. 1960.

The ascal wall of this species turns blue in Melzer's reagent. It was transferred to Svrcekia by Kubička (1960).

Barlaeina microspora CUP-CA-65

No record of this name has been found. A fragment of an apothecium was found in this packet, which was identified as Marcelleina pseudoanthracina (Donadini) Krist.& Mor.

Barlaea recurva (Berk.) Sacc., Syll. Fung. 8: 116. 1889.

≡ Plicaria recurva (Berk.) Rifai, Ver. Kon. Ned. Aka. Wet. Nat. II. 57: 256. 1968.

Although this species has globose ornamented spores, the asci turn blue in Melzer's reagent, and the apothecia are large. This should be a species of Plicaria.

Barlaea subaurantiaca Massee, J. Bot., Lond. 34: 147. 1896.

≡ Barlaeina subaurantiaca (Massee) Sacc. & Syd., in Sacc. Syll. Fung. 14: 749. 1899.

≡ Peziza subaurantiaca (Massee) Rifai, Verh. K. Ned. Akad. Wet. Nat. II 57: 248. 1968.

The hymenium of this species gives a weak positive reaction in Melzer's reagent. It should be included in Peziza.

Barlaea persoonii (Cr. & Cr.) Sacc., Syll. Fung. 8: 116. 1889.

≡ Barlaeina persoonii (Cr. & Cr.) Sacc. & Trav., Syll. Fung. 19: 140. 1910.

≡ Marcelleina persoonii (Cr.& Cr.) Brumm., Persoonia, Suppl. 1: 233. 1967.

This is the type species of Marcelleina. It has purple apothecia and is usually found on soil.

Lamprospora amethystina (Quel.) Seaver, Mycologia 6: 16. 1914.

≡ Barlaea amethystina (Quel.) Sacc., Syll. Fung. 8: 116. 1889.

No materials of Seaver's collections could be found, but from the description, the apothecial color is whitish or purplish. This might be a species of Marcelleina or Greletia (see Pfister, 1985).

Lamprospora asperella (Rehm) Boud., Hist. Class. Discom. Eur. 69. 1907.

≡ Crouania asperella Rehm, Hedwigia 24: 226. 1885.

≡ Barlaea asperella (Rehm) Sacc., Syll. Fung. 8: 113. 1889.

= Ramsbottomia asperior (Nyl.) Benkert & Schum., Agarica 6: 35. 1985.

Benkert (1987) considered this species a synonym of Ramsbottomia asperior. I agree with his designation.

Lamprospora astroidea (Hazsl. ex Cooke) Boud., His. Class. Disc. d'eur. 68. 1907.

≡ Peziza astroidea Hazslinszky ex Cooke in Grevillea 4: 41. 1875.

≡ Barlaea astroidea (Hazsl. ex Cooke) Sacc., Syll. Fung. 8: 111. 1889.

Boudier cited this epithet under Lamprospora, but without any descriptions. Saccardo (1898) and Maas (1969) described this as a round smooth spored species. Benkert (1987) cited this as a synonym to L. carbonicola.

Lamprospora brevispinosa Seaver, North Am. Cup-Fungi. 63. 1942.

No specimen of this species was discovered.

Lamprospora crec'hqueraultii (Cr.) Boud., Hist. Class. Discom. d'Eur. 69. 1907.

≡ Barlaea crec'hqueraultii (Cr.) Sacc., Syll. Fung. 8: 113. 1889.

≡ Barlaeina crec'hquerault*ii* (Cr.) Sacc. & Trott., Sacc. Syll. Fung. 22: 612. 1913.

≡ Ramsbottomia crec'hquerault*ii* (Cr.) Benkert & Schum., Agarica. 6: 33. 1985.

Benkert and Schumacher (1985) transferred this species to Ramsbottomia. I agree with this transfer.

Lamprospora crec'hquerault*ii* (Cr.) Boud. Var. modesta (Karst.) Gamundi, Fl. cript. tierra del fuego 10: 130. 1975.

≡ Crouania modesta (Karst.) Karst., Acta Soc. Fauna Fl. Fenn. 2: 118. 1885.

≡ Barlaea modesta (Karst.) Sacc., Syll. Fung. 8: 1113. 1889.

= Ramsbottomia asperior (Nyl.) Benkert et Schum., Agarica. 6: 35. 1985.

= Sphaerospora perplexa Seaver, North Am. Cup-Fungi (oper.) 45. 1942.

Because of the soil habitat, brown apothecial hairs and spiny spores, this species should be included in Ramsbottomia. Seaver (1942) commented that S. perplexa may be another form of L. crec'hquerault*ii*.

Lamprospora chopraiana Batra, Mycologia 52: 665. 1960.

No apothecia were found with this specimen, but according to its description, this is not a Lamprospora

species. Rifai (1968) excluded it from Lamprospora (see Pfister, 1976).

Lamprospora detonii Brenckle, Mycologia 8: 38. 1916.
= Scabropezia flavovirens (Fuckel) Dissing & Pfister, Nord. J. Bot. 1: 104. 1981.

This species is found on soil and the ascal tips turn blue in Melzer's reagent. It should not be included in Octospora.

Lamprospora exasperata (Berk. & Curt.) Seaver, North Amer. Cup-fungi (oper.) 75. 1928.
≡ Barlaea exasperata (Berk. & Curt.) Sacc., Syll. Fung. 8: 112. 1889.
≡ Peziza exasperata Berk. & Curt. in Berk. Grevillea 3: 152. 1875.

Seaver (1942) misplaced this species in Lamprospora. Because of the amyloid asci, Pfister (1979) transferred it back to Peziza.

Lamprospora fulgens Snyder, Mycologia 28: 484. 1936.
≡ Pseudoplectania fulgens (Pers. ex Fr.) Fuckel, Symb. Myc. 324. 1869.
≡ Barlaea fulgens (Pers. ex Fr.) Rehm, in Rab. Krypt.-Fl.1: 930. 1896.

≡ Caloscypha fulgens (Pers. ex Fr.) Boud., Hist. Class. Discom. d'Eur. 54. 1907.

Seaver (1942) put this species in Pseudoplectania. Because of its soil habitat and hairs on the apothecia, it should be excluded from Lamprospora.

Lamprospora gemmea (Phill.) Seaver, Mycologia 6: 18. 1914.

≡ Barlaea gemmea (Phill.) Sacc., Syll. Fung. 8: 112. 1889. = Pulvinula archeri (Berk.) Rifai, Verh. K. Ned. Akad. Wet.II. 57: 213. 1968.

Because of the soil habitat and smooth-walled spores, this should be a species of Pulvinula.

Lamprospora georgii Svrček, Ces. Mycol. 12: 229. 1958.

≡ Marcelleina georgii (Svrček) Moravec, Mycotaxon. 30: 482. 1987.

Because of the soil habitat and purple apothecia, this should not be included in Octospora.

Lamprospora haemastigma (Hedw.) Seaver, Mycologia 6: 17. 1914.

≡ Pulvinula haemastigma Boud. Hist. Class. Discom. Eu. 70. 1907.

Boudier (1907), Le Gal (1953) and Seaver synonymized this species with P. convexella. Pfister (1976) considered this is a nomen confusum. Because of the smooth walled

spores and delicate paraphyses, this should be a species of Pulvinula.

Lamprospora haemastigma var. gigantea Thind & Batra, J. Indian Bot. Soc. 38: 221. 1959.

≡ Pulvinula haemastigma (Hedw. ex Fr.) Boud. var. gigantea (Thind & Singh) Waraitch & Thind, J. Nat. Hist. Mus. 1: 21-34. 1977.

Pfister (1976) considered this is a variety of P. convexella group. This species has larger spores than P. haemastigma.

Lamprospora iathina 1896. CUP-D 843.

= Marcelleina rickii (Rehm) Graddon, Trans. Brit. Mycol. Soc. 66: 170. 1976.

No record of this name was found. This specimen was identified as Marcelleina rickii.

Lamprospora jetelae Vacek, Stud. Bot. Čechoslov. 10: 133. 1949.

= Marcelleina rickii (Rehm) Graddon, Trans. Brit. Mycol. Soc. 66: 170. 1976.

The purple apothecia and soil habitat confirm that this should not be a species of Octospora

Lamprospora knajaschensis (Karst.) Boud., Hist. Class. Discom. d'Eur. 68. 1907.

According to the original description, it has smooth spores and curved paraphyses. It should be a species of Pulvinula (see Pfister, 1976).

Lamprospora lobata (Berk.& Curt.) Seaver, Mycologia 6: 22. 1914.

≡ Barlaea lobata (Berk. & Curt.) Sacc., Syll. Fung 8: 117 1889.

≡ Lazuardia lobata (Berk.& Curt.) Rifai, Mycotaxon 31: 239-244. 1988.

This species is found on soil, and the apothecia are brown and large. It should be included in a new genus (Rifai, 1988).

Lamprospora leiocarpa (Curr.) Seaver, Mycologia 6: 21. 1914.

= Plicaria endocarpoides (Berk.) Rifai, Verh. K. Ned. Akad. Wet II. 57: 255. 1968.

The ascal wall of this species turns blue in Melzer's reagent, and the apothecia are dark brown. It should be included in Plicaria.

Lamprospora modestissima Grelet, Bull. Soc. Mycol. France 52: 204. 1927.

= Lamprospora tuberculata Seaver, Mycologia 4: 47. 1912.

No apothecia were found in the packet, but according to the description of Grelet (1927), this species is synonymous with L. tuberculata.

Lamprospora macrantha (Boud.) Seaver, N. Amer. Cup-Fungi (oper.) 63. 1928.

≡ Lamprospora crec'hqueraultii (Cr.) Boud. var macrantha Boud., Hist. Class. Discom. Eur. 69. 1907.

≡ Ramsbottomia macracantha (Boud.) Benkert & Schum., Agarica 6: 37. 1985.

This species is characterized by globose spiny spores. Because of the soil habitat and the excipular structure, this should be included in Ramsbottomia.

Lamprospora multiguttula Batra, Mycologia 52: 665. 1960.

The original collection is represented only by a slide. Rifai annotated this specimen as Pulvinula constellatio. Globose, smooth spores would exclude this species from Octospora (see Kaushal, 1982).

Lamprospora mussooriensis Thind, Cash & Singh, Mycologia 51: 457. 1959.

≡ Pulvinula mussooriensis (Thind, Cash & Singh) Batra & Batra, Kansas Univ. Sci. Bull. 44: 167. 1963.

This species is found on soil, has smooth spores and curved paraphyses. It should be included in Pulvinula.

Lamprospora nigrans (Morgan) Seaver, Mycologia 6: 20. 1914.

This is a species of Plicaria, Seaver transferred it from Detonia.

Lamprospora ovalispora (Svr. & Kub.) Eckbl., Nytt. Mag. Bot. 15:42. 1968.

≡ Lamprospora crec'hqueraultii (Cr.) Boud. var. ovalispora Svr. & Kub., Česka Mykol. 17: 67. 1963.

= Barlaea modesta (Karst.) Sacc., Syll. Fung 8: 113. 1889.

= Ramsbottomia asperior (Nyl.) Benkert & Schum., Agarica 6: 35. 1985.

The soil habitat and spiny spores show this is a species of Ramsbottomia.

Lamprospora planchonis (Dun.) Seaver, Mycologia 6: 21. 1914.

= Greletia planchonis (Dun. ex Boud.) Donadini, Bull. Soc. Mycol. France. 95: 184. 1979.

This species is found on soil, has dark purple apothecia, and curved paraphyses. Donadini transferred it to Greletia (see Pfister, 1985).

Lamprospora polytrichina (Rehm) Seaver, Mycologia 6:23. 1914.

≡ Detonia polytrichina Rehm, in Rab. Krypt.-Fl. 1: 1269. 1896.

= Peziza polytrichi Schum., Enum. Pl. Saell. 2: 423. 1803.

≡ Barlaea polytrichi Sacc., Syll. Fung. 8: 113. 1889.

≡ Plicariella polytrichi Lindau, in E. & P. Nat. Pfl. 1: 180. 1897.

Boudier (1907) employed the epithet polytrichi for a warted-spored species, but Le Gal (1940), recalling the name Peziza polytrichi, published it as L. polytrichi. In Australia the name L. polytrichina (Rehm) Seaver was used as a synonym of Pulvinula miltina (Rifai, 1968). Seaver's description and specimens fit those of a Pulvinula. Lamprospora polytrichina should be excluded from Lamprospora, and L. polytrichi is synonymous with O. carbonicola in this study.

Lamprospora pyrophila Snyder, Mycologia 228: 484. 1936.

= Pulvinula archeri (Berk. in Hook.) Rifai, Verh. K. Ned. Akad. Wet. II. 57: 213. 1968.

Because of the soil habitat and hooked, branched paraphyses, this should be a species of Pulvinula.

Lamprospora salmonicolor Seaver, Mycologia 17: 47. 1925.

≡ Pulvinula salmonicolor (Seav.) Pfister, Phytologia 24: 211. 1972.

Because of the soil habitat and even marginate apothecia, this should not be included in Octospora but in Pulvinula as suggested by Pfister (1976).

Lamprospora tetraspora Hansf., Proc. Linn. Soc. New South Wales 79: 126. 1954.

≡ Pulvinula tetraspora (Hansf.) Rifai, Verh. K. Ned. Akad. Wet. II. 57: 207. 1968.

This species is characterized by having four spores in each ascus at maturity. Because of the soil habitat and delicate paraphyses, this should not be included in Octospora, but in Pulvinula as suggested by Rifai (1968).

Lamprospora trachycarpa (Curr.) Seaver, Mycologia 6: 19. 1914.

≡Plicaria trachycarpa (Curr.) Boud., Hist. Class. Discom. d'Eur. 50. 1907.

This is the type species of Plicaria (Korf 1960). Seaver (1942) transferred this species from Plicaria.

Lamprospora verruculosa (Berk. & Br.) Boedijn, Sydowia 5: 211. 1951.

≡ Barlaeina verruculosa (Berk. & Br.) Petch, Ann. R. Bot. Gard. Perad. 6: 169. 1916.

= Barlaeina albocaerulescens Penz. & Sacc., Malpighia 15: 202. 1901.

= Lazuardia lobata (Berk. & Curt.) Rifai, Mycotaxon 31: 239-244. 1988.

This species is characterized by unique spore ornamentations. Because of the brown apothecia and soil

habitat, this should not be a species of Octospora (see Rifai, 1988).

Lamprospora wisconsinensis Seaver, North Amer. Cup-Fungi (oper.) 69. 1928.

≡ Pulvinula laeterubra (Rehm) Pfister, Farl. Herb. Harv. Univ. 9: 11. 1976.

Seaver (1942) used this epithet to substitute Barlaea laeterubra Rehm, and emphasized that it was not the same species as Peziza laetirubra Cooke. Pfister (1976) discussed this epithet along with laetirubra. According to the description, this should be a species of Pulvinula.

Fig. 31. Q. areolata.

A). Diagrammatic median section of apothecium.
B). Ascospore with prominent ridges.
C). Asci with 8 spores.
D). Paraphyses tips.
E). Details of median section of apothecial margin.

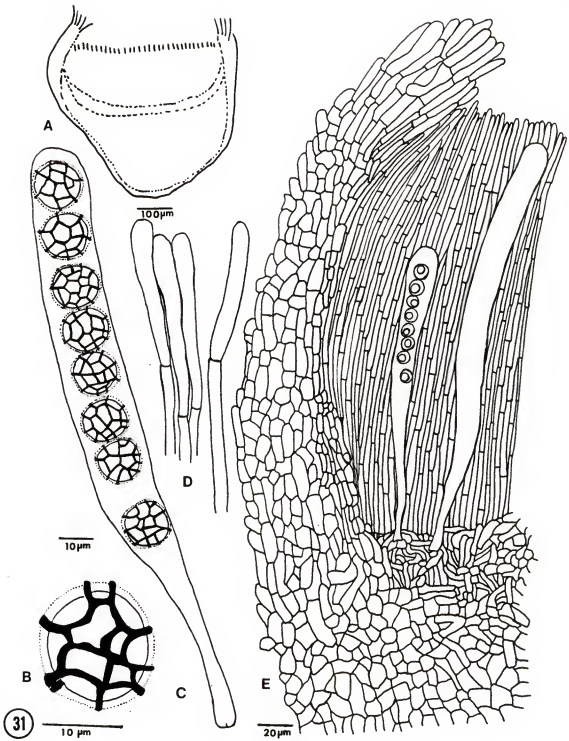

A
100µm
D
10µm
B
C
E
31
10 µm
20µm

Fig. 32. Q. arvensis.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospores.
D). An ascus and paraphysis tips.
E). Ascal bases.

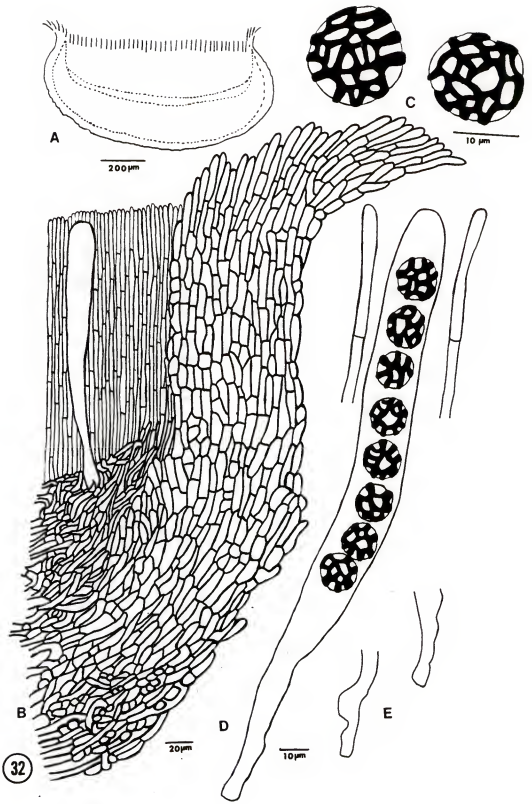

A
200µm
C
10 µm
B
20µm
D
10µm
E
32

Fig. 33. Q. australis.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospores.
D). An ascus and paraphyses tips.
E). Details of excipular texture.

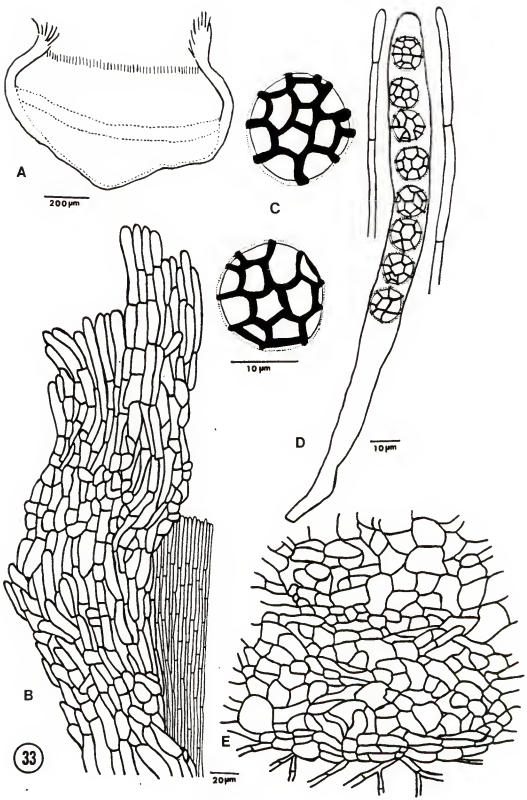

A
200 µm
C
10 µm
D
10 µm
B
20 µm
E
33

Fig. 34. Q. campylopodis.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospores.
D). Paraphyses tips.
E). An ascal base.
F). An ascus with 8 spores.

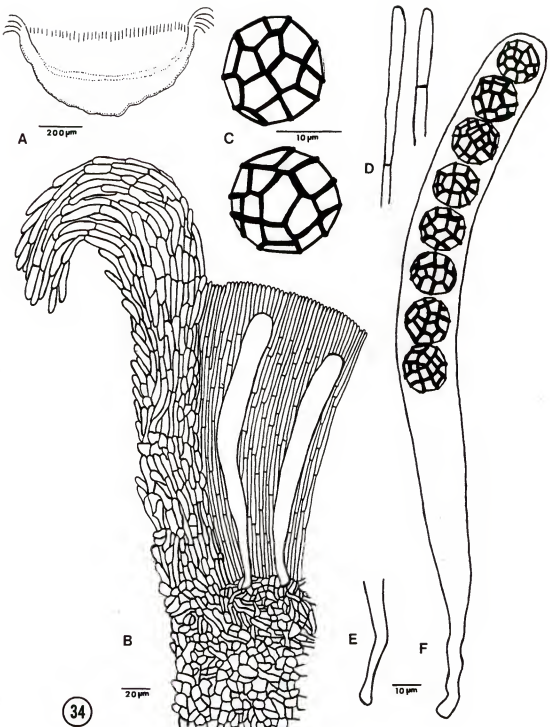

A
200 µm
C
10 µm
D
B
20 µm
E
F
10 µm
34

Fig. 35. O. carbonicola.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospores.
D). An ascus with 8 spores.
E). Paraphyses tips.
F). An ascal base.

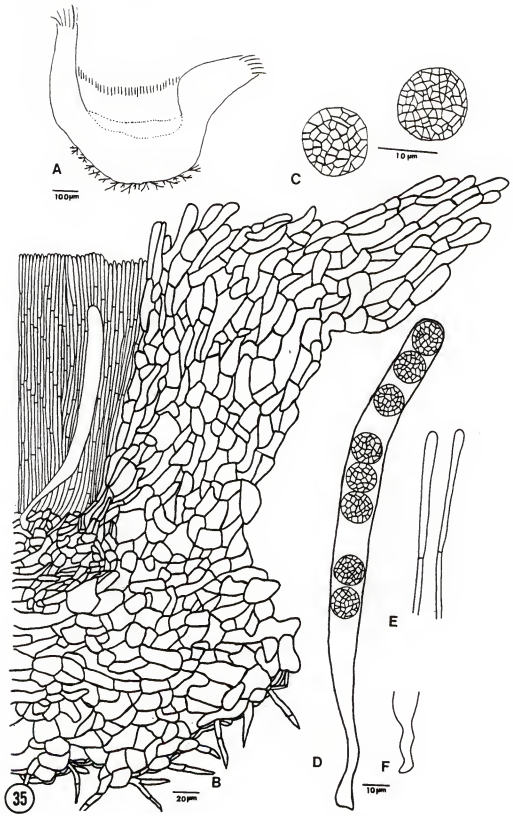
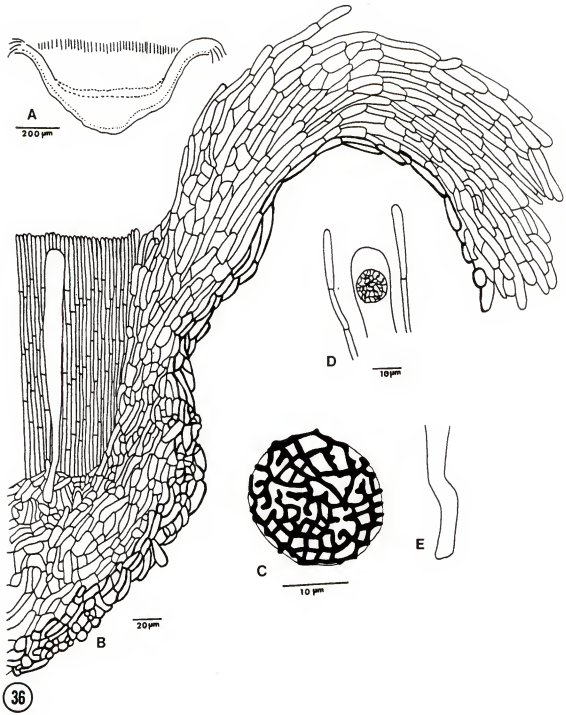

A
100µm
C
10 µm
B
20µm
D
E
F
10µm
35

Fig. 36. O. ditrichi.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospore.
D). Ascal and paraphyses tips.
E). An ascal base.



36

Fig. 37. Q. feurichiana.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). An ascus with 8 spores.
D). An ascal base.
E). Paraphyses tips.
F). Ascospores.

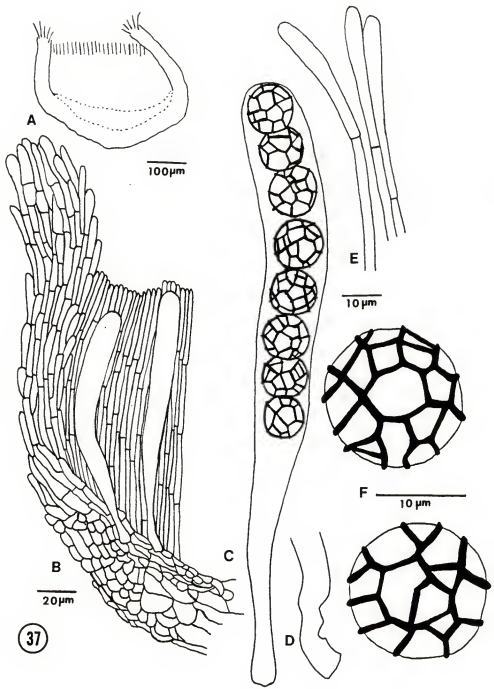

A
100µm
B
20µm
C
D
E
10µm
F
10µm
37

Fig. 38. O. hanffii.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospore with close reticulations.
D). Ascospore with broad reticulations.
E). An ascus with 8 spores.
F). Paraphyses.

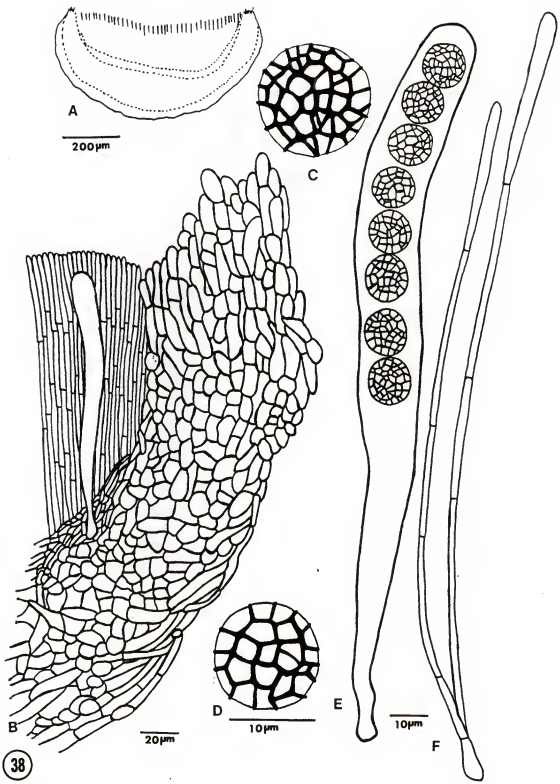

A
200µm
C
B
20µm
D
10µm
E
10µm
F
38

Fig. 39. Q. marieana.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospores.
D). An ascus with 8 spores.
E). Paraphysis tip.

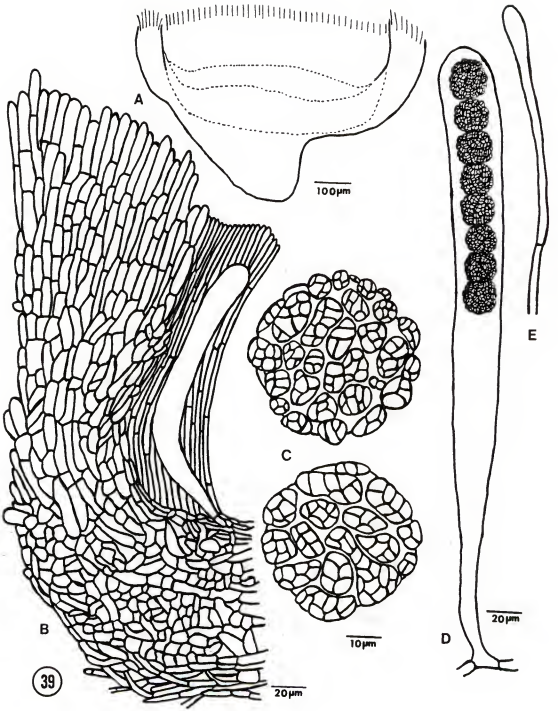

A
100µm
B
C
10µm
D
20µm
E
20µm
39

Fig. 40. Q. miniata.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospores.
D). Paraphysis tip.
E). An ascus with 8 spores.

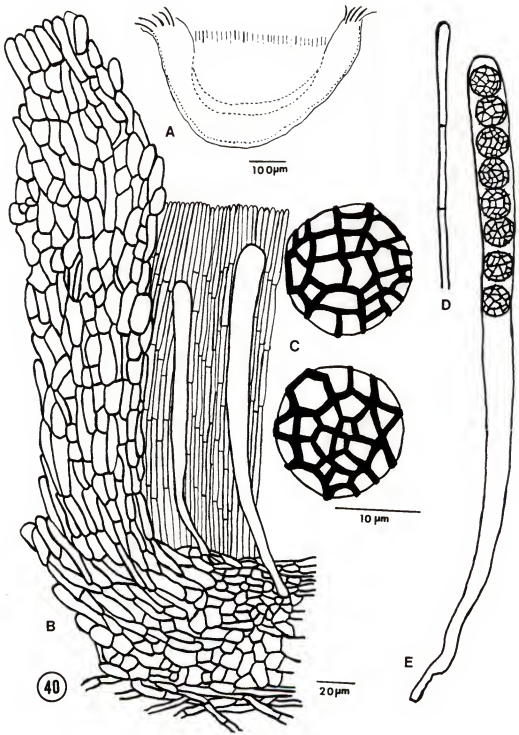
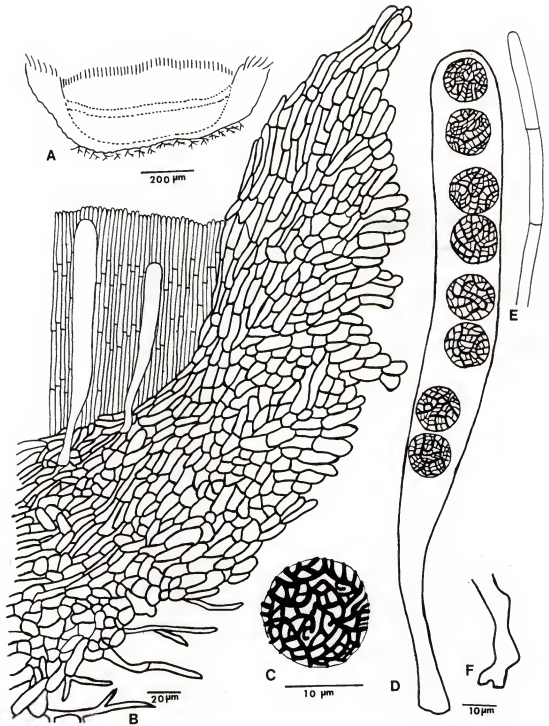

A
100µm
B
C
10 µm
D
E
20µm
40

Fig. 41. Q. seaveri.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospore.
D). An ascus with 8 spores.
E). Paraphysis tip.



41

Fig. 42. O. spinulosa.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). Ascospores.
D). Paraphysis tip.
E). An ascus with 8 spores.

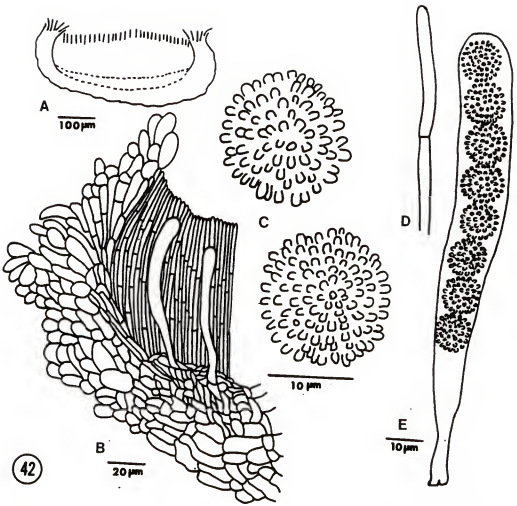
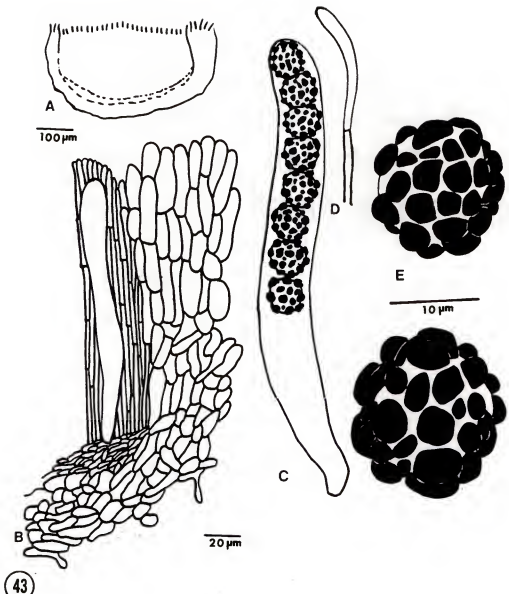

A
100µm
B
20µm
C
10µm
D
E
10µm
42

Fig. 43. Q. tuberculata.

A). Diagrammatic median section of apothecium.
B). Details of median section of apothecial margin.
C). An ascus with 8 spores.
D). Paraphysis tip.
E). Ascospores.



43

Fig. 44. O. tuberculatella.

A). Diagrammatic median section of apothecium.
B). Ascospores.
C). An ascus with 8 spores.
D). Paraphyses tip.
E). Details of median section of apothecial margin.

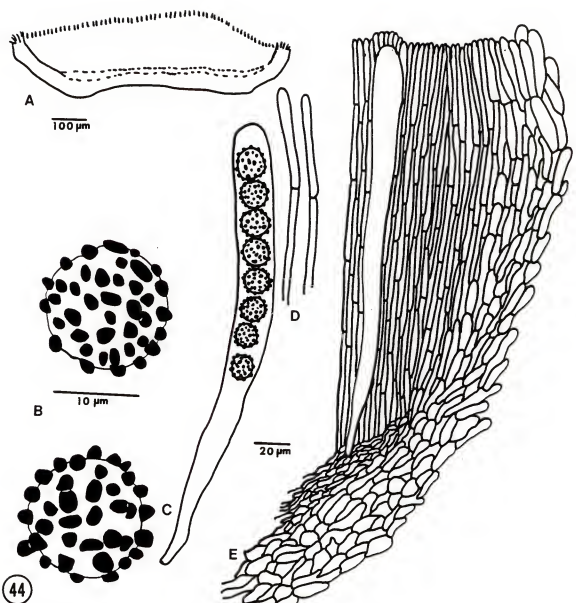
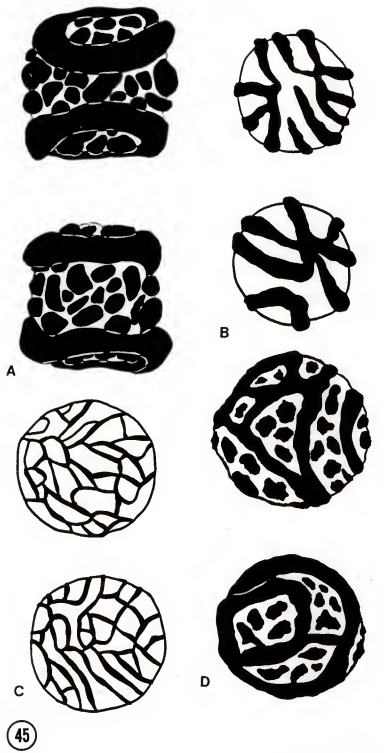

A
100 µm
B
10 µm
C
D
20 µm
E
44

Fig. 45. Two ascospores each of four Octospora species.

A). O. annulata.
B). O. ascoboloides.
C). O. paechnatzii.
D). O. dicranellae.



(45)

Figs. 46-52. Ascospores of Octospora species. The bar represents 50 µm.

Fig. 46. O. annulata.

Fig. 47. O. australis.

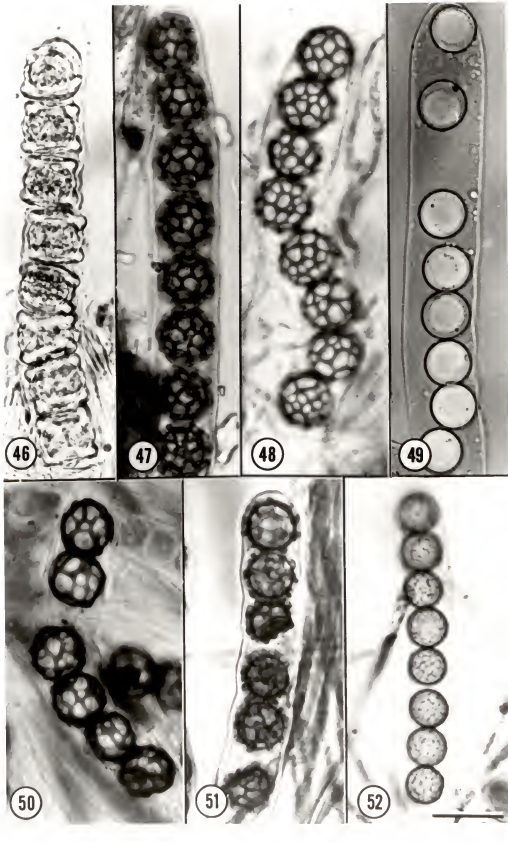
Fig. 48. O. campylopodis.

Fig. 49. O. campylopodis with spores ornaments dissolved after KOH treatment.

Fig. 50. O. arvensis.

Fig. 51. O. areolata.

Fig. 52. O. carbonicola.


46
47
48
49
50
51
52

Figs. 53-61. Ascospores of Octospora species. The bar represents 50 μm.

Fig. 53. O. hanffii.

Fig. 54. O. feurichiana.

Fig. 55. O. marieana.

Fig. 56. O. marieana with spore ornaments dissolved after KOH treatment.

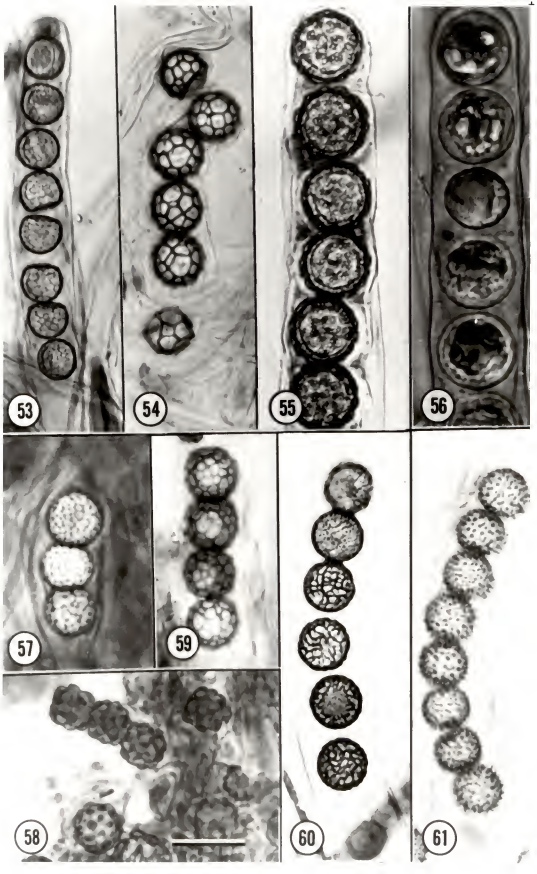
Fig. 57. O. ditrichi.

Fig. 58. O. tuberculata.

Fig. 59. O. miniata.

Fig. 60. O. seaveri.

Fig. 61. O. spinulosa.


53
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58
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61

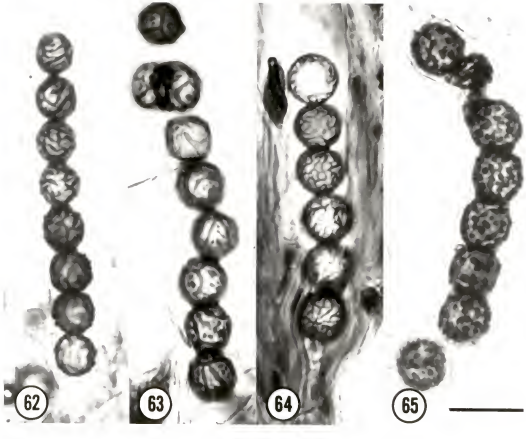
Figs. 62-65. Ascospores of Octospora. The bar represents 50 μm.

Fig. 62. O. ascoboloides.

Fig. 63. O. dicranellae.

Fig. 64. O. paechnatzii.

Fig. 65. O. tuberculatella.


62
63
64
65

CHAPTER 6
SUMMARY AND CONCLUSION

In the past, Lamprospora was characterized by globose spores and an angular-celled excipulum (Rifai, 1968). Le Gal (1969) and Caillet and Moyne (1980) merged the species of Lamprospora with Octospora, but Benkert (1987) retained Lamprospora and transferred three spiny-spored species to Ramsbottomia.

In this study, over six hundred herbarium specimens were studied by using different stains, reagents, and frozen and plastic sections. Among these specimens, ninety-nine specimens were identified as Lamprospora (sensu Benkert, 1987) species. This genus is characterized by a bryophilic habitat, small red, glabrous apothecia with membranous fimbriate margins, one layered excipulum and a thin hyphal outer layer, operculate inamyloid asci, globose hyaline guttulate ornamented ascospores, and straight paraphyses. The fungal species and associated moss genera are summarized. Excipular structure is classified as two types: differentiated and nondifferentiated. The former group has equally thick ectal excipulum of textura angularis and medullary excipulum of textura intricata; the latter group has an excipulum of textura angularis or textura intricata.

Spore ornamentation varies widely among species. Four trends of spore ornamentation were observed, i.e., spinose, tuberculous, ridged, and reticulate, along with two intermediate types, i.e., tubercles with ridges and incomplete reticulation. Pulvinula was selected as an outgroup for a cladistic analysis among selected species of Ramsbottomia, Octospora and Lamprospora. Seventeen characters were employed. The data were analyzed by using Hennig86 (Farris 1988), and six equal parsimonious trees (length=25, CI=0.68) were discovered. The consensus tree of these six trees shows that Ramsbottomia form a clade distinct from that including species of Octospora and Lamprospora. Lamprospora is a paraphyletic group as currently delimited, and the species of Lamprospora and Octospora shared a common ancestor. The most derived species within Lamprospora have reticulate spores. Thus, Lamprospora is synonymized with Octospora as emended. Eighteen species are emended and described. Forty-two species are excluded from this group. This cladistic study supports the establishment of Ramsbottomia and the merging of Lamprospora with Octospora.

Few studies have been done among this group of fungi. Seaver (1912) stated the difficulties of studying Lamprospora are due to the tiny apothecia which are easily overlooked in nature and preserved herbarium specimens. Dennis and Itzerott (1973) also mentioned that these fungi

should be collected at an appropriate time of the year. However, detailed studies of ellipsoid-spored species of Octospora are needed.

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BIOGRAPHICAL SKETCH

Yei-Zeng Wang was born in Keelung, Taiwan, Republic of China, on December 27, 1956. She attended public schools in Keelung, and graduated from Chung-Sun Girls High School, Taipei in 1971. In 1979, she went to teach biology and chemistry in An-Lo Junior High School to fulfill the internship for teachers, and received her B.S. degree in biology from National Taiwan Normal University the next year. After teaching in the same school for another year, she was admitted to the Biological Science Institute of Taiwan Normal University. She studied mycology under Dr. Chiu-Yuan Chien's guidance and received the degree of Master of Science in biology in June 1983. For the next four years, she was employed as a lecturer at Der-Yu Junior Nursing College, in Keelung. She began her graduate studies towards the Doctor of Philosophy degree in botany under the direction of Dr. James W. Kimbrough in August 1987.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

James W. Kimbrough, Chairman
Professor of Botany

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Professor of Botany

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Walter S. Judd
Professor of Botany

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Henry C. Aldrich
Professor of Microbiology
and Cell Science

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Saeed R. Khan
Assistant Professor of
Pathology and Laboratory
Medicine

This dissertation was submitted to the Graduate Faculty of the Department of Botany in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December 1991

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Dean, Graduate School